Operating and Service Manual

GOULD

GOULD BRUSH

MANUAL PART NO.
15-806687-01

BC 568210
568211

BRUSH 481 RECORDER
ALL MODELS

OFFICIAL RECORDS STATION
FILE COPY
FACILITIES
JAN 14 1976

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Gould Inc., Instrument Systems Division
3631 Perkins Avenue-Cleveland, Ohio 44114

4TH PRINTING
PRINTED IN U.S.A.

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Brush 481 Recorder (Figure 1-1) is a general purpose analog recorder featuring eight 40mm analog channels, two event markers, 12 pushbutton-controlled chart speeds, and eight isolated preamplifiers with differential, floating, and balanced to guard inputs and sensitivities from one millivolt per division to 500 volts full scale. Frequency response is flat from d-c to 40 Hz full scale, to 100 Hz at 10 divisions (±2% of full scale).

Controls, including 13-step input signal attenuators, intermediate sensitivity, and pen position, are provided on the front panel for each analog channel. Adjustable internal electronic pen limits on the amplifiers prevent analog pen damage from excessive off-scale input signals.

A pressurized ink system enables pens to write dry, smudge-free traces. Disposable plastic ink cartridges can be replaced in minutes. If power is lost or chart paper supply is exhausted, the writing system stops immediately and ink is withdrawn from the pen tip back into the system. Ink "puddling" cannot occur.

A pen-position servo system, based on a frictionless transducer, assures extreme accuracy. Penmotor and transducer are fully enclosed and are immune to wear, time and dirt.

This rugged recorder is available with portable carrying case or slide adapter for rack mounting (refer to Para. 1.3, Supplies and Accessories).

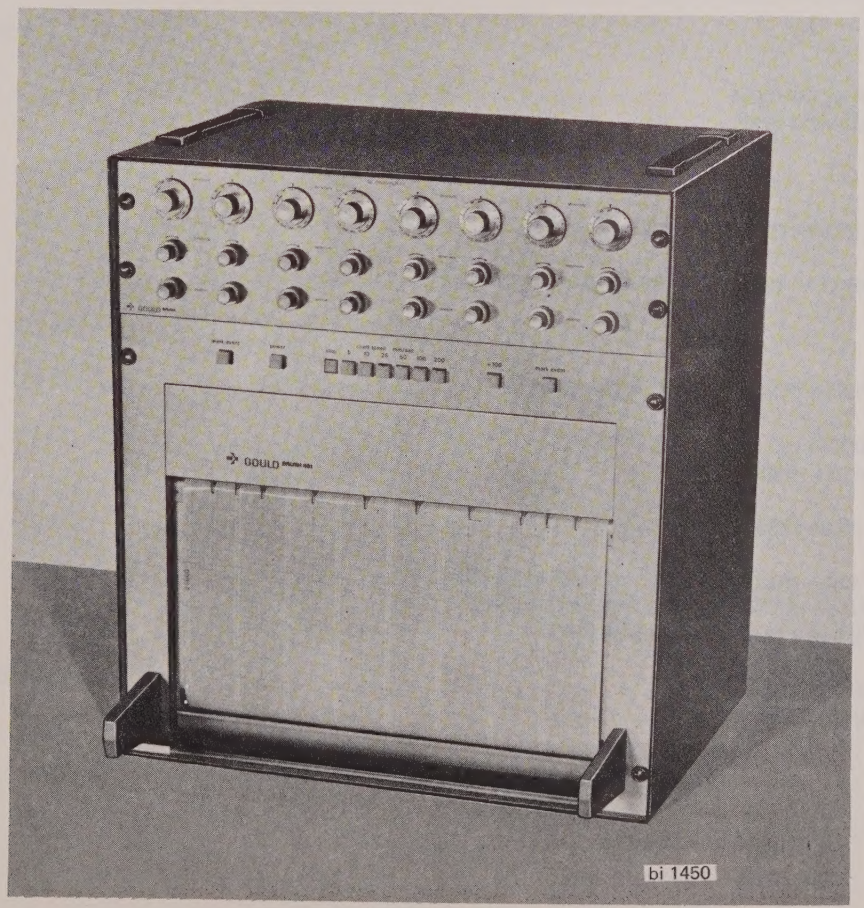


FIGURE 1-1 BRUSH 481 RECORDER

1.2 SPECIFICATIONS

a. General

Number of Channels	8 analog and 2 event markers located between channels 1 & 2 and 7 & 8
Channel Span	40mm (50 divisions)
Trace Presentation	Rectilinear
Trace Width	0.01 in. nominal
Marking Method	Pressurized marking fluid
Marking Fluid Capacity	Three 1-oz cartridges (sufficient for one year of normal recording); replaceable throwaway cartridge
Chart Speeds	12 speeds pushbutton (electrically) selected: 0.05, 0.1, 0.25, 0.5, 1.0, 2.0, 5, 10, 25, 50, 100 and 200 mm/sec
Chart Speed Accuracy	±0.25%
Chart Length	High-contrast – 300 feet Reproducible – 450 feet
Chart Width	15 inches
Chart Divisions	50 divisions in 40 mm(wide), 1 mm(time)
Rewind	External – see Para. 1.3, Supplies and Accessories

b. Signal Inputs

Circuit	Differential, floating, and balanced to guard
Impedance	10 megohms balanced, 5 megohms each terminal to guard
Sensitivity	1 mv/div to 500 volts d-c full scale
In-Phase Rejection	80 dB at 60 Hz with maximum source unbalance of one kilohm at one mv/div sensitivity setting (decreasing on higher sensitivity settings)
Maximum Signal Input	500 volts d-c, or peak a-c (either input to ground)

Maximum Common Mode Voltage . . . . . a) 500 volts d-c or peak a-c at any attenuator setting between input terminals and case ground.

b) 5,000 times the VOLTS/DIV sensitivity setting up to a maximum of 500 volts between input terminals and guard

ATTENUATOR SETTING	MAX COMMON–MODE VOLTAGE
1 mv/div	5V d-c
2 mv/div	10V d-c
5 mv/div	25V d-c
10 mv/div	50V d-c
20 mv/div	100V d-c
All others	500V d-c

c. **Recorder Characteristics**

Deflection Non-Linearity . . . . . 0.5% of full scale

Frequency Response (peak-to-peak) . . . . . 50 divs ±1 div d-c to 40 Hz
10 divs ±1 div d-c to 100 Hz
10 divs ±1 div 3 dB down at 125 Hz

Noise . . . . . 0.2 div maximum

Stability, after 15 minute warm-up (excluding paper drift)

Zero with Time . . . . . ±0.1 div per 8 hours

Zero with Temperature . . . . . ±0.1 div per °C, 25° C, ±10° C

Zero with Line Voltage . . . . . ±0.05 div per volt ±10% line variation

Gain with Time . . . . . ±0.2% per 8 hours

Gain with Temperature . . . . . ±0.05% per °C, 25° C ±10° C

Gain with Line Voltage . . . . . ±0.05% per volt, ±10% line variation

Power Input . . . . . 115V a-c ±10%; 60 Hz, 300 watts (375 va) Model 15-6687-01
230V a-c ±10%; 50 Hz, 300 watts (375 va) (Model 15-6687-06)

Operating Temperature . . . . . 0° C to 55° C

Storage Temperature . . . . . –40° C to 85° C

Dimensions . . . . . Refer to outline drawing 282977

Weight . . . . . 110 lbs (approximate)

1.3 SUPPLIES AND ACCESSORIES

Analog Pen	11-2823-33
Extended Life Analog Pen	11-2823-34
Event Marker Pen	11-2873-20
Ink Cartridge, Blue	11-2730-01
Chart Paper	
High-Contrast – 300 feet (for use with or without Z-fold)	11-2983-300
Reproducible – 450 feet	11-2983-40
Tools	
Pen Tubing Removal Tool	267528
Pen Replacement Wrench (Multiple splined)	1-120922-2
Pen Pressure Adjustement Wrench (Multiple splined)	1-120922-18
Gram Gage (Pen pressure)	240601-910
Band Replacement Tool	341409-915
Band Replacement Wrench (Multiple splined)	1-120922-3
Band Replacement Wrench (Hex)	245218-5
Portable Case Assembly	11-1115-31
Slide Mounting Kit (19 inch)	11-1202-21
External Chart Takeup	11-6402-06
Z-Fold Chart Paper Adapter	11-2271-21
Z-Fold Chart Paper	11-2983-300
Event Market Kits	
Left Hand Margin	11-6222-02
Interchannel	11-6222-02
Right Hand Margin	11-6222-01
One Second Timer	RA 2101-10
Signal Input Connectors (Analog)	234321

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the inspection checks to be performed upon receipt of the Brush 481 Recorder and describes power requirements and signal connections. In addition, this section describes and illustrates installation of Event Marker Kits, External Chart Takeup, Portable Case Mounting, and Slide Mounting.

2.2 INCOMING INSPECTION

Perform the following procedures before operating the recorder.

1. Visually inspect unit for damage that may have occurred during shipment. Refer to warranty sheet in case of damage.

2. Remove packing material and tape from recorder.

NOTE: Do not attempt to operate this equipment before completing Section III, Operation.

2.3 POWER REQUIREMENTS

Connect power cable to correct power source listed below for applicable model.

Model No.	Power Source
15-6687-01	115 volts a-c±10%,60 Hz, 300 watts
15-6687-06	230 volts a-c±10%;50 Hz, 300 watts

2.4 SIGNAL CONNECTIONS

a. Analog

Inputs to analog channels should be made using a shielded two-conductor cable. (Belden 8422 or equivalent). Input connectors (part number 234321) are to be wired as follows:

Signal High	Pin 1
Signal Low	Pin 2
Shield (guard)	Pin 3

b. Event Markers

Event Markers may be actuated by an external switch closure (short) across terminals located on recorder rear connector panel.

Resistance of each event marker coil is 600 ohms at –32V d-c, connected from an internal source.

2.5 INTERNAL TIMER INSTALLATION (RA 2101-10)

To install one second timer, proceed as follows:

1. Prepare four timer leads by attaching a push-on terminal, Brush part number 265840-1 (Amp, Inc., number 60573-1).

NOTE: Crimping tool is AMP, Inc., of Harrisburg, Pa., part number 47042 (for terminal 60573-1).

2. Mount timer using two screws, lockwashers and hex nuts (supplied with timer). Refer to Figure 2-1 for timer location and connection of leads.

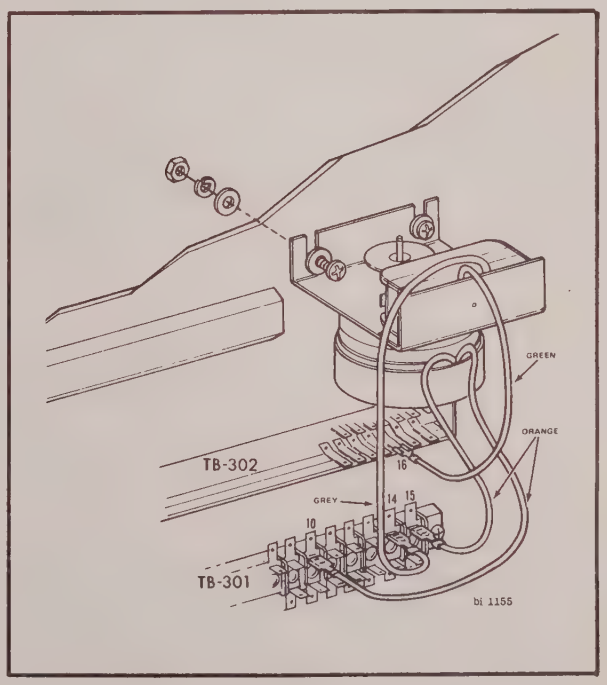


FIGURE 2-1 TIMER INSTALLATION

3. Connect timer leads as follows:

Orange	TB-301-15
Orange	TB-301-10
Grey	TB-301-14
Green	TB-302-16

Timer Model RA 2101-10 is an accessory, and although it may be factory installed, the timer output may be easily changed to actuate any desired event marker. Refer to Figure 2-2 and make connections as shown.

NOTE: Solid lines in Figure 2-2 do not indicate factory installed wiring. All wiring shown in Figure 2-2 must be installed as shown. Only one event marker may be connected at any time. These connectors are located behind rear connector panel.

2.6 ACCESSORY EVENT MARKERS

The Brush 481 Recorder may use up to seven event markers, two standard and five accessory. To aid in locating event markers, they are identified as follows:

Event Marker	Location	Deflection
A	Left Margin	Right
B	Between Analog 1 & 2 (standard)	Right
C	Between Analog 2 & 3	Right
D	Between Analog 4 & 5	Right
E	Between Analog 6 & 7	Right
F	Between Analog 7 & 8 (standard)	Right
G	Right Margin	Left

Event Markers A, B, C, D, E and F are Model 11-6222-02. Installation is described on drawing 669788. Event Marker G is model 11-6222-01. Installation is described on drawing 669693. Event Marker G cannot be used if chart paper Z-fold adapter is used, since ink trace may trigger folder mechanism.

2.7 PORTABLE CASE INSTALLATION

The Brush 481 Recorder may easily be adapted for use as a portable instrument using portable case, Model 11-1115-31. For complete installation instructions, refer to drawing 683014.

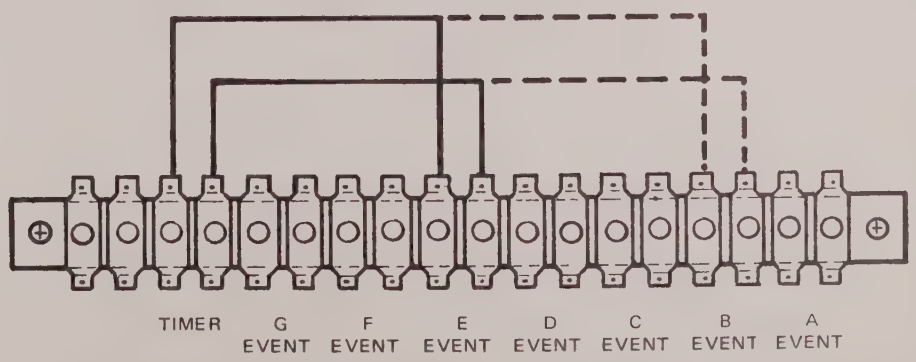
NOTE: Recorder should not be lifted by handles alone, since unit weight is in excess of 100 lbs.

2.8 SLIDE MOUNTING KIT INSTALLATION

The Brush 481 Recorder is designed for installation in a 19" RETMA mounting rack. However, to provide greater ease in sericing, recorder may be mounted on pullout slides, using slide mounting kit, Model 11-1202-21. For complete installation instructions, refer to drawing 683000.

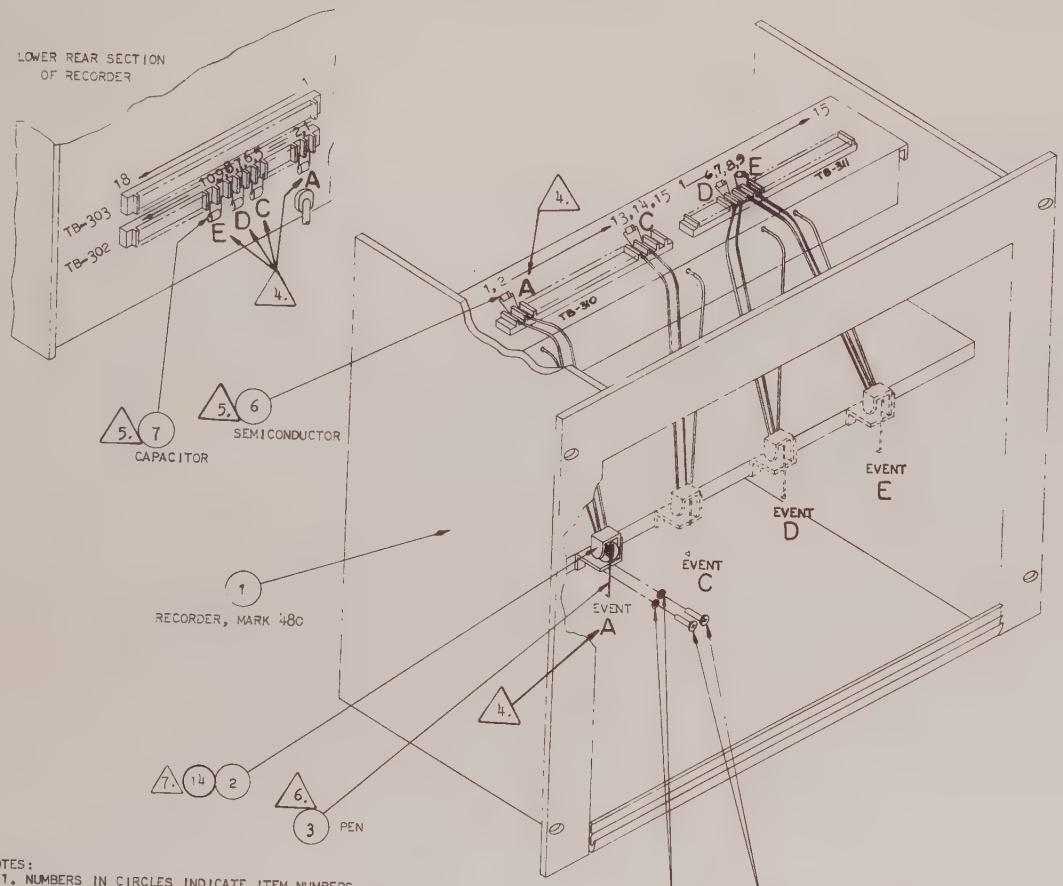
2.9 CHART TAKEUP INSTALLATION

External Chart Takeup, Model 11-6402-06 can be easily installed on the Brush 481 Recorder. For complete installation instructions, refer to drawing 669664.



NOTES:
1. Typical connections for accessory timer.
2. Solid lines show connection to Event "E"
3. Dotted lines show connection to Event "B"
4. Timer must not be connected to more than one (1) event marker at any time

FIGURE 2-2 EVENT MARKER - TIMER INTERCONNECTIONS



NOTES:
1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. MOUNT 2 & 14 TO PENMOTOR MOUNTING BAR, USING 4 & 5.
3. CONNECT THE TWO WIRES FROM 2 TO TERMINALS AS SHOWN.
4. CORRESPONDING LETTERS OF COMPONENTS INDICATE MATING PARTS IN TYPICAL EVENT MARKER CIRCUIT.
5. CONNECT COMPONENTS TO TERMINALS AS INDICATED.
6. MOUNT 3 TO 2 AS SHOWN. REMOVE AND DISCARD FACTORY SUPPLIED PLASTIC CAP, CONNECT INK TUBE AS SHOWN.
7. ITEM-14 TO BE ASSEMBLIED BETWEEN EVENT MT'G. BRACKET & PEN MOTOR BAR.
8. REQUIRED ONLY WHEN MOUNTING EVENT MARKER TO 15-6687-00.

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REVISIONS			E-1
SYM.	DESCRIPTION		DATE
A-1	ADDED ITEM 14 & REV NOTE 2. DCN 12524 E.P.		8-23-69
B-1 B2	EVENT "D" WAS TERM 8 & 9 EVENT "E" WAS TERM. 9 & 10 DCN 12558 & 12658		2-2-70 SMMCT.
C-1	ADDED NOTE 7. B.BROD DCN 12732		
D-1	ADDED PG. 2, ITEMS 15 & 16 AND NOTE 8 DCN 15050		5-25-71
E-1	PG. 2 REV. WIRE CALLOUT [redacted] 15117 EP		7-2-71
F-1	ADDED ITEM-17 & NOTE 8 DCN 15967	BROD	9-18-71

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	NO.	BRUSH PART NO.	DESCRIPTION	QUAN.
	30			
	29			
	28			
	27			
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	25			
	24			
	23			
	22			
	21			
	20			
	19			
	18			
8.	17	13-262716-4006	SCREW, SELF-TAPPING	2
	16	15-806347-00	MANUAL, OPERATING	-
8.	15	15-6347-00	RECORDER, MARK 480	-
	14	280050	SPACER	1
	13	269789	SCHEMATIC	1
	12	669788	SHIP. LIST & INSTALL. INST.	1
	11	422642	ENVELOPE, MANUAL	-
	10	15-806687-00	MANUAL, OPERATING	-
	9	240273-1	BAG, PLASTIC	1
	8	222640	CARD, CONCEALED DAMAGE	1
	7	10-241145-224	CAPACITOR	1
	6	231887	SEMICONDUCTOR	1
	5	13-262716-4004	SCREW, SELF-TAPPING	2
	4	1-118195-304	WASHER, PLAIN	2
	3	11-2873-20	PEN ASSY	1
	2	11-6222-02	EVENT MARKER KIT	1
	1	15-6687-00	RECORDER, MARK 480	-

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APP'D		

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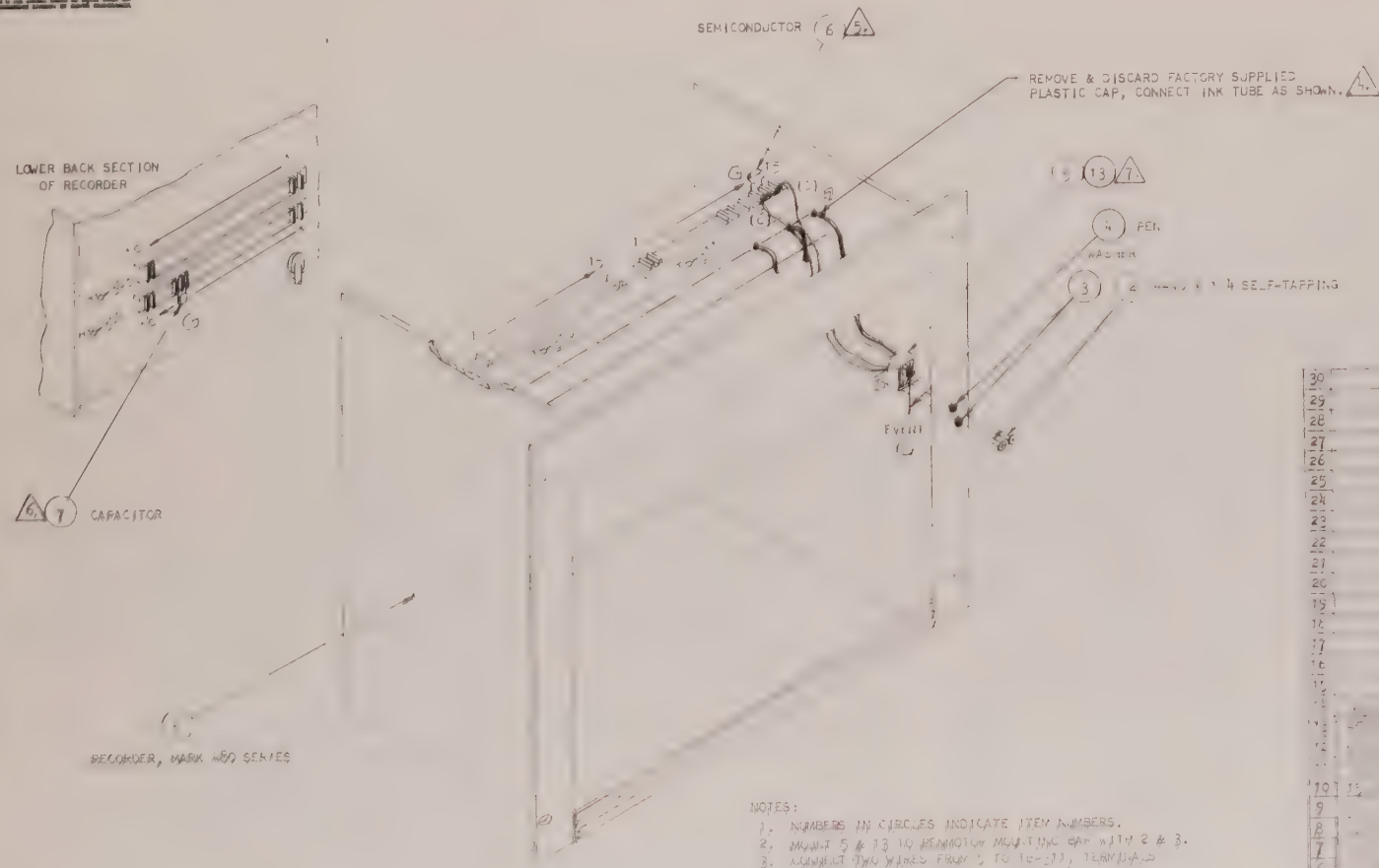
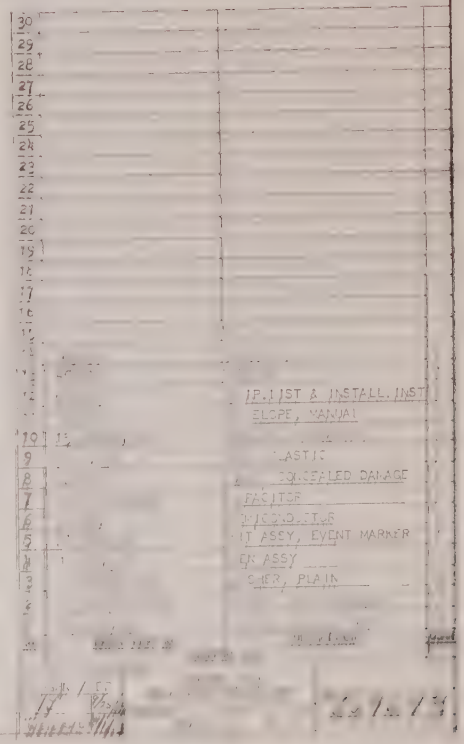

SEMICONDUCTOR
REMOVE & DISCARD FACTORY SUPPLIED PLASTIC CAP, CONNECT INK TUBE AS SHOWN.
LOWER BACK SECTION OF RECORDER
CAPACITOR
RECORDER, MARK 480 SERIES
EVENT

NOTES:

1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. MOUNT 5 & 13 TO TERMINAL MOUNTING BAR WITH 2 & 3.
3. CONNECT TWO WIRES FROM [illegible] TO TB-[illegible], TERMINALS [illegible] & [illegible] AS SHOWN.
4. MOUNT [illegible] TO [illegible]
5. [illegible] TO TB-[illegible], TERMINALS [illegible] & [illegible] (SOLDER)
6. [illegible]
7. [illegible]



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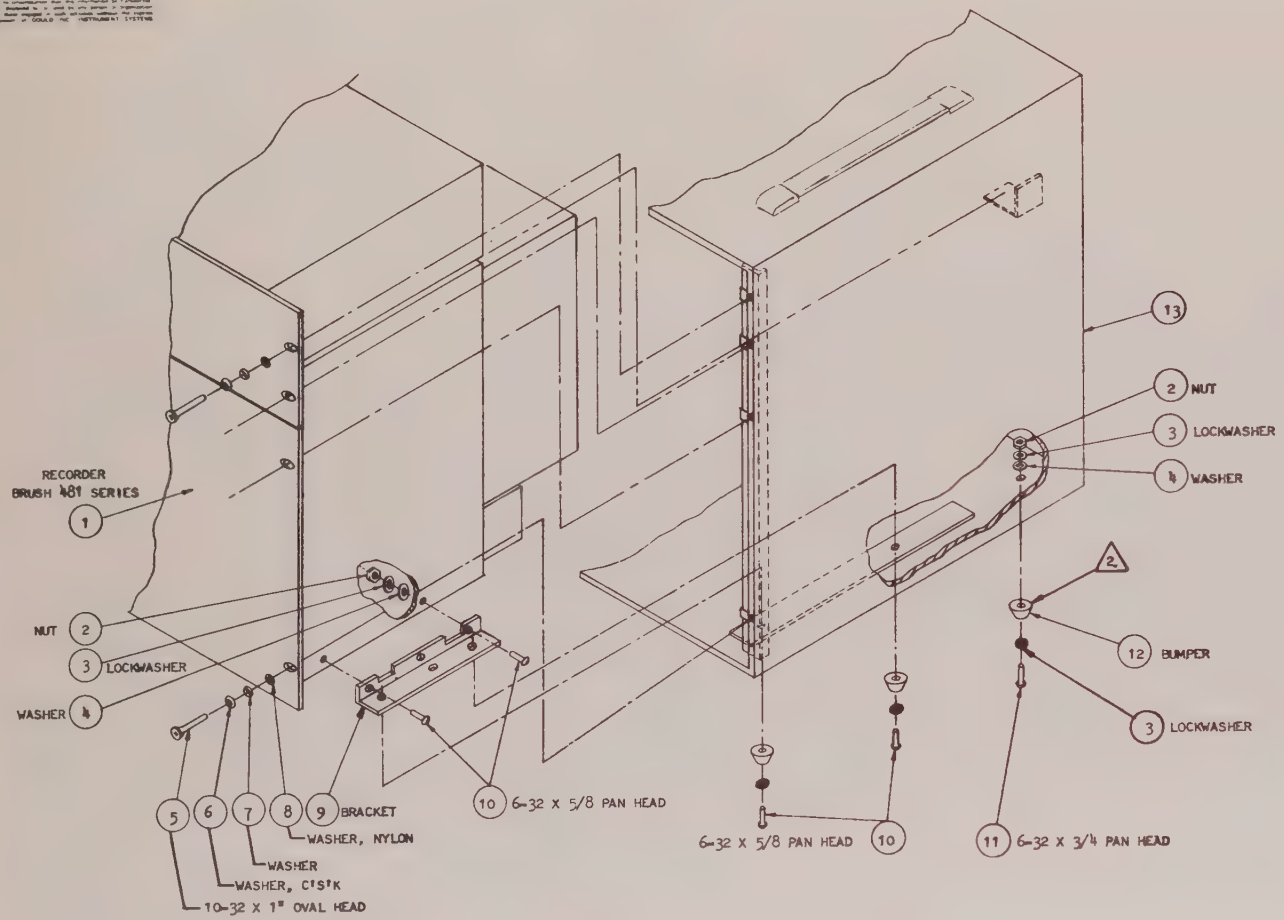

NOTES:
1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. ASSEMBLE THE TWO REAR FEET, 12, AND FOUR BRACKETS, 9, BEFORE 1 IS INSERTED INTO 13.
3. INSERT 1 INTO 13, THEN ASSEMBLE FRONT FOUR FEET, 12, TO SECURE UNIT AS SHOWN.
4. INSTALLATION TYPICAL OF BOTH SIDES.

NO.	BRUSH PART NO	DESCRIPTION	QUAN
30			
29			
28			
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26			
25			
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23			
22			
21			
20			
19			
18			
17	683014	SHIP. LIST & INSTALL INST.	1
16	228640	CARD, CONCEALED DAMAGE	1
15	-228612	ENVELOPE, MANUAL	-
14	15-28667-01	MANUAL, OPERATING	-
13	[illegible]	CASE ASSEMBLY	1
12	26-385	BUMPER	6
11	31-119918-6212	SCREW, PAN HEAD	2
10	31-119918-6210	SCREW, PAN HEAD	8
9	285119	BRACKET	2
8	128967-1	WASHER, PLAIN - NYLON	8
7	126138-2	WASHER	8
6	31-[illegible]-10	WASHER, C'S'K	8
5	31-121534-0216	SCREW, OVAL HEAD	8
4	1-118195-305	WASHER, PLAIN	6
3	1-216741-420	LOCKWASHER, SPRING	12
2	31-119998-62	NUT, HEX	6
1	15-6687-01	RECORDER, BRUSH 481	-

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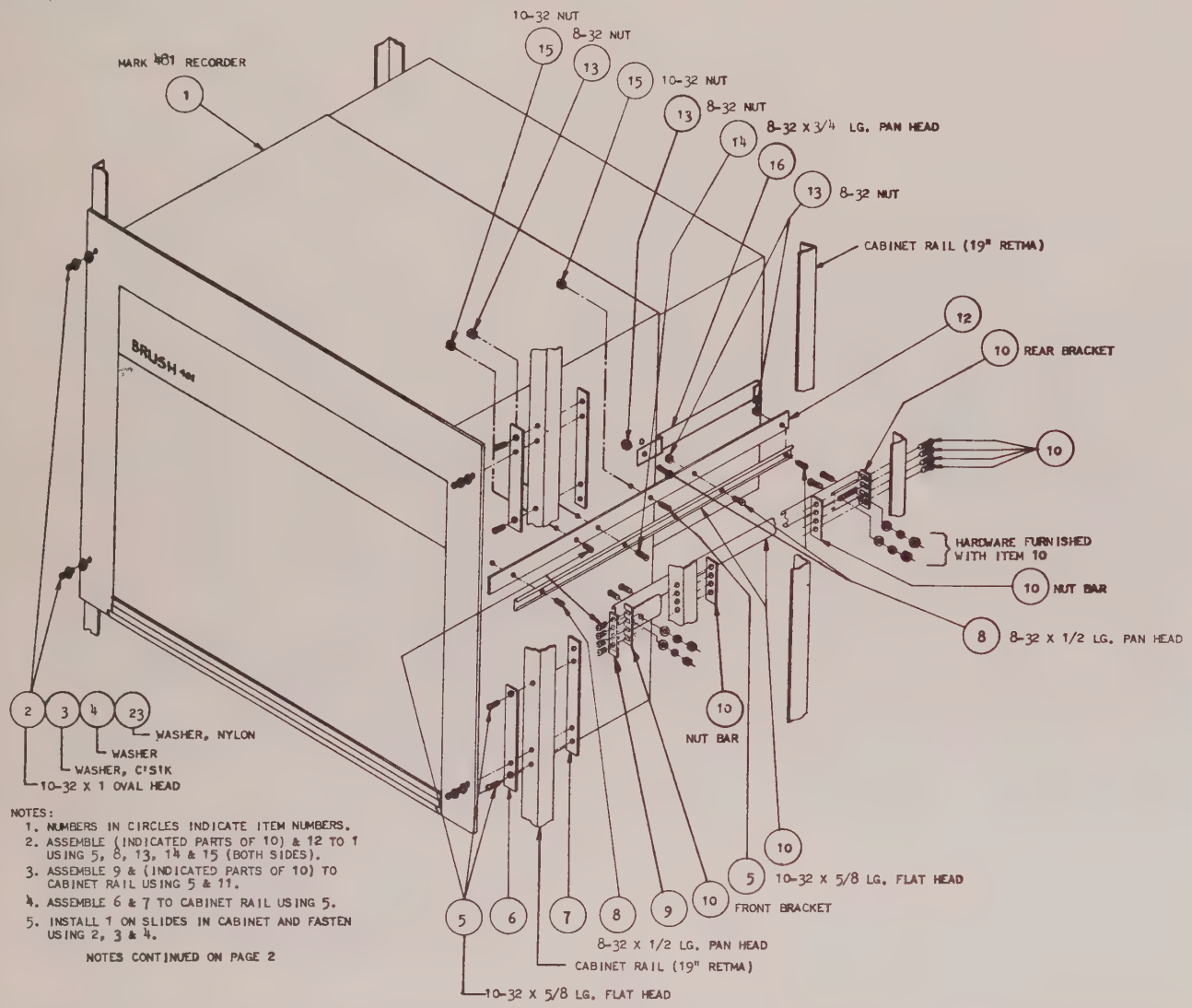

NOTES:
1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. ASSEMBLE (INDICATED PARTS OF 10) & 12 TO 1 USING 5, 8, 13, 14 & 15 (BOTH SIDES).
3. ASSEMBLE 9 & (INDICATED PARTS OF 10) TO CABINET RAIL USING 5 & 11.
4. ASSEMBLE 6 & 7 TO CABINET RAIL USING 5.
5. INSTALL 1 ON SLIDES IN CABINET AND FASTEN USING 2, 3 & 4.

NOTES CONTINUED ON PAGE 2

NO.	BRUSH PART NO.	DESCRIPTION	QUAN
30	31-119998-02	NUT, HEX.	4
29	345982	SLIDE, REAR R.H.	1
28	345983	SLIDE, REAR L.H.	1
27	246200	NUT, BAR	4
26	445984	SUPPORT	2
25	31-119918-0208	SCREW, PAN HD.	12
24	31-121534-0220	SCREW, OVAL HD.	4
23	128967-1	WASHER, PLAIN, NYLON	4
22	683000	SHIP. LIST & INSTAL. INST.	1
21	422642	ENVELOPE, MANUAL	-
20	15-806687-01	MANUAL, OPERATING	-
19	CABINET	19" RETMA	-
18	11-1202-21	KIT ASSY., RACK MTG.	1
17	222640	CARD, CONCEALED DAMAGE	1
16	269737	SPRING, RACK LOCK	1
15	243898-02	NUT, ASSEMBLED LOCKWASHER	4
14	31-119918-8212	SCREW, PAN HD.	2
13	243898-82	NUT, ASSEMBLED LOCKWASHER	7
12	269623	SPACER, SLIDE	2
11	31-119918-0210	SCREW, PAN HD.	8
10	269569-5	SLIDES, PAIR	1
9	265678	SPACER, CENTER	2
8	31-119918-8208	SCREW, PAN HD.	5
7	269625	NUT PLATE	4
6	269624	SPACER	4
5	31-119920-0210	SCREW, FLAT HEAD	1
4	126138-9	WASHER, NYLON	8
3	31-120650-10	WASHER, C'SIK, HOLLOW	8
2	31-121534-0216	SCREW, OVAL HEAD	4
1	15-6687-01	MARK 481 RECORDER ASSY.	-

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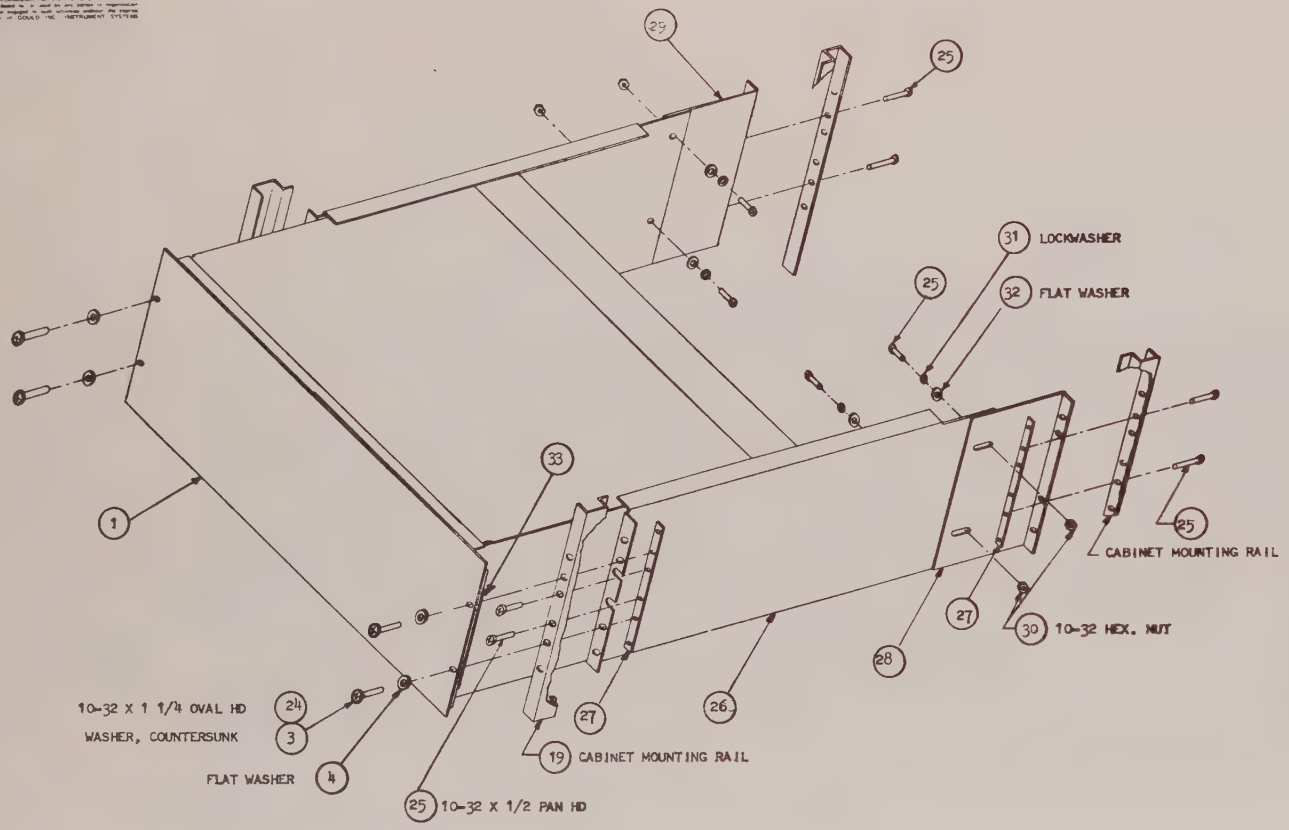

CTD. NOTES:

6. ASSEMBLE 26 & 27 TO 19 USING 25.
7. ASSEMBLE 27 & 28 TO 19 USING 25.
8. ASSEMBLE 26 & 28 USING 25, 30, 31 & 32.
9. OPPOSITE SIDE: REPEAT NOTES 6, 7 & 8.
10. INSTALL 1 IN CABINET & FASTEN BOTH SIDES WITH 24, 3 & 4.

NO	BRUSH PART NO.	DESCRIPTION	QUAN
35			
34			
33	249562	PLATE, SPACER	2
32	1-118195-309	WASHER	4
31	1-216741-430	LOCKWASHER, SPRING	4

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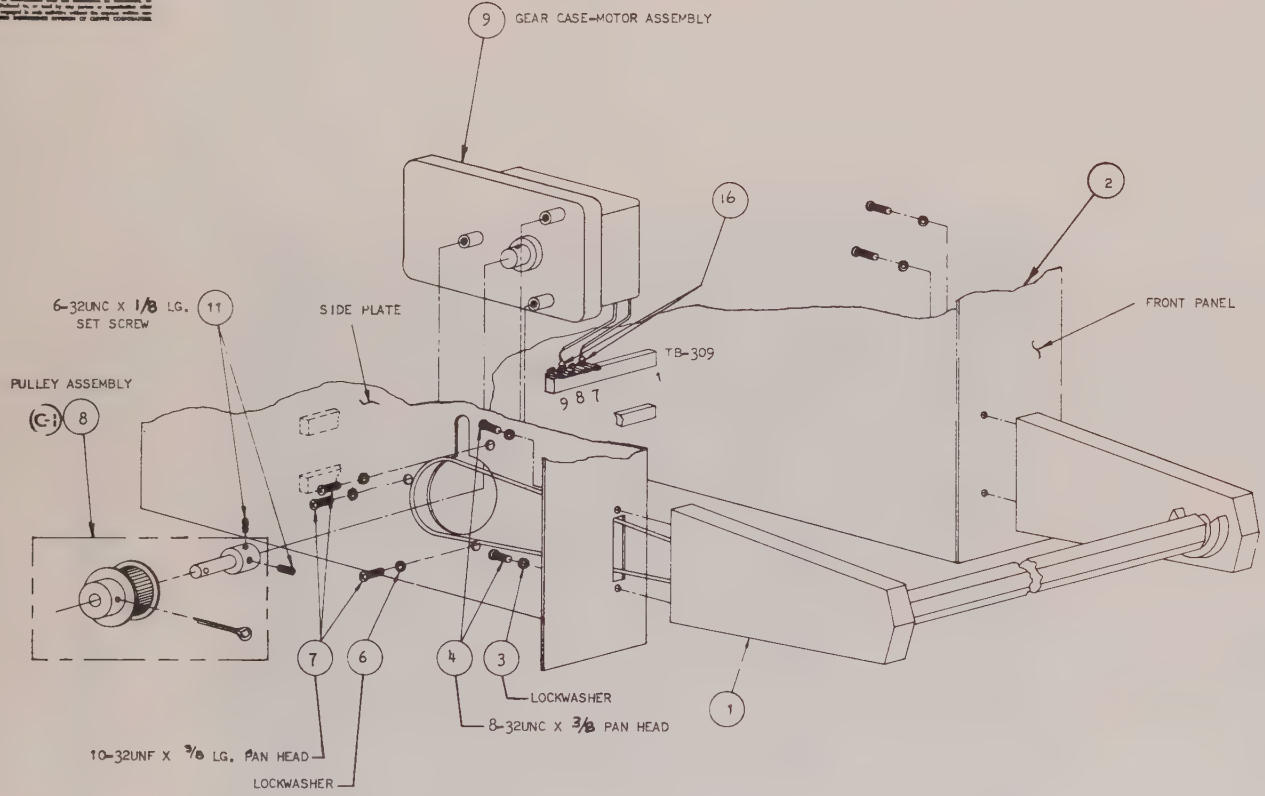

NOTES:
1. NUMBERS IN CIRCLES INDICATE ITEM NUMBERS.
2. ASSEMBLE ARMS OF 1 TO FRONT PANEL USING 3 & 4.
3. ASSEMBLE MOTOR USING 6 & 7
4. ASSEMBLE 8 (PULLEY ASSEMBLY) TO MOTOR SHAFT USING 11.
5. CONNECT MOTOR LEADS TO TB-309, TERMINALS 7 & 9 (EITHER LEAD TO EITHER TERMINAL).

NO.	BRUSH PART NO.	DESCRIPTION	QUAN
30			
29			
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19			
18			
17			
16	265840-2	TERMINAL, LUG	2
15	669664	SHIP.LIST & INSTALL.INST.	1
14	422642	ENVELOPE, MANUAL	1
13	15-806687-00	MANUAL, OPERATING	-
12	222640	CARD, CONCEALED DAMAGE	1
11	31-119923-6202	SCREW, SET	2
10			
9	747033	GEAR CASE-MOTOR ASSY	1
8	680147	PULLEY ASSY	1
7	31-119918-0206	SCREW, PAN HEAD	3
6	10-120053-104	LOCKWASHER, EXT.T	3
5			3
4	31-119918-8206	SCREW, PAN HEAD	4
3	1-216741-425	LOCKWASHER, SPRING	4
2	15-6687-00	RECORDER MK-480	-
1	11-6402-06	CHART TAKE-UP ASSY	1

SHIPPING LIST

BY	DATE	NAME
DR BROD/	EP	SHIPPING LIST & INSTALLATION INSTRUCTIONS
CH V.P.		
APP L.W.		

CODE IDENT 96795 ISSUE CODE G

DWG. NO. 669664

SECTION III

OPERATION

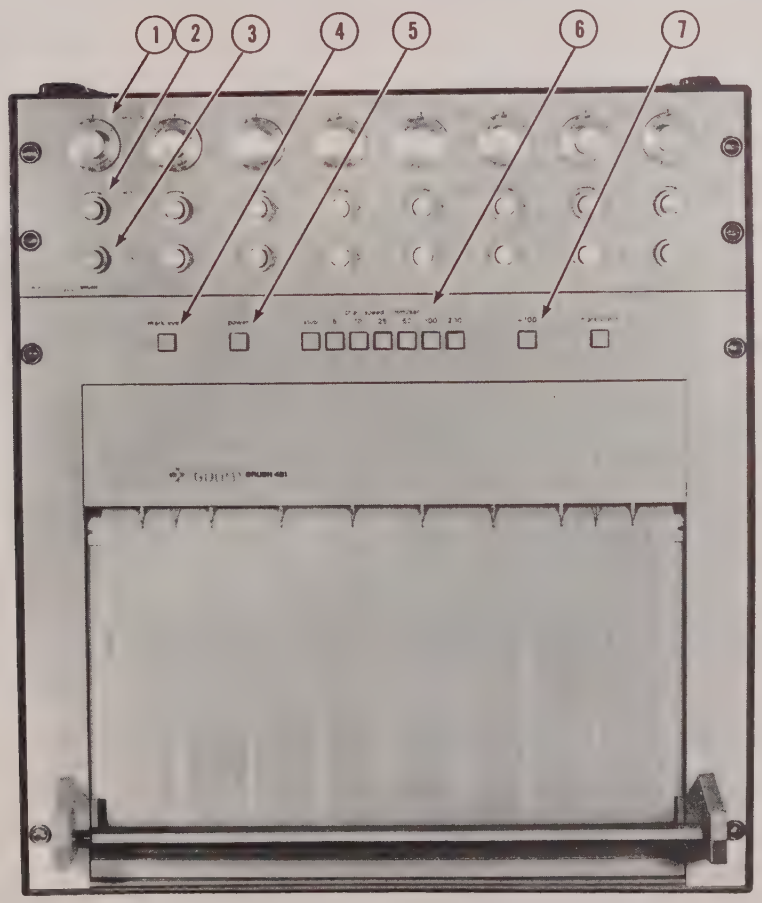
3.1 GENERAL

This section describes and illustrates the controls on the Brush 481 and also provides instructions for proper operation.

3.2 FRONT PANEL

NOTE: Item numbers listed below correspond to circled numbers in Figure 3-1.

1 SENSITIVITY . . . . . Provides 13 step attenuation of input signal from one millivolt per division to 10 volts per division, and off.



bi 1452

FIGURE 3-1 FRONT PANEL CONTROLS

2 SENSITIVITY X1 . . . . . Provides intermediate sensitivities between the fixed settings of the stepped SENSITIVITY control. When in the full clockwise (detent) position, the sensitivity is fixed as indicated on the stepped SENSITIVITY control.

When rotated counterclockwise, the sensitivity is less than indicated on stepped SENSITIVITY control to a maximum ratio of 2.5 to 1. This control is fitted with a locking nut to prevent inadvertent turning.

NOTE: This is a variable control, but not calibrated.

3 POSITION . . . . . Permits pen positioning anywhere within the channel and thus allows either edge of channel, or any point in between, to be used as zero signal position. This control is fitted with a locking nut to prevent inadvertent turning.

4 MARK EVENT switch . . . . . Two momentary switch permit manual marking of an event. When left MARK EVENT button is depressed the left event marker (event B located between analog channels 1 and 2) will deflect to right. When right MARK EVENT button is depressed the right event marker (event F located between analog channels 7 & 8) will deflect to right.

NOTE: The event marker pens will remain deflected until the MARK EVENT button is released.

5 POWER switch . . . . . Controls a-c power to recorder. Depress button to turn recorder on or off. An internal lamp illuminates the pushbutton when recorder is on.

6 CHART SPEED MM/SEC switch . . . . . Permits selection of twelve chart speeds and STOP. When in STOP position chart drive mechanism and ink supply is off, and pens will not respond to input signals. Depressing any chart speed button activates recorder at selected chart speed. Chart speeds may be changed at any time without impairing writing quality.

7 ÷ 100 . . . . . With button depressed, all chart speeds are divided by 100. Speeds are 0.05, 0.1, 0.25, 0.5, 1 and 2 mm/sec. Chart speeds, including ÷ 100 may be changed at any time without impairing writing quality.

3.3 REAR PANEL

NOTE: Item numbers listed below correspond to circled numbers in Figure 3-2.

8	Analog Input Receptacle	Provides signal inputs to each recording channel. (Silk-screened numbers correspond to channel numbers.) Refer to Para. 2.4a for connections.
9	Preamplifier Balance Control	Used during calibration of recorder (Refer to Section VI, Calibration).
10	TIMER	Activates optional internal one second timer accessory, Model RA 2101-10. Timer output may be jumpered to any standard or accessory event marker input terminal as shown in Figure 2-4.
11	Event Marker Input Jacks	Two jacks (one pair for each channel) which permit remote actuation of event marker. Placing a short between these two jacks will deflect the event marker. Pen will remain deflected until short is removed. **NOTE: When using internal timer with any event marker, be sure remote input jacks are disconnected.**
12	AUX	Convenience outlet, switch on with main POWER switch.
13	Fuses	For recorder and auxiliary outlet.

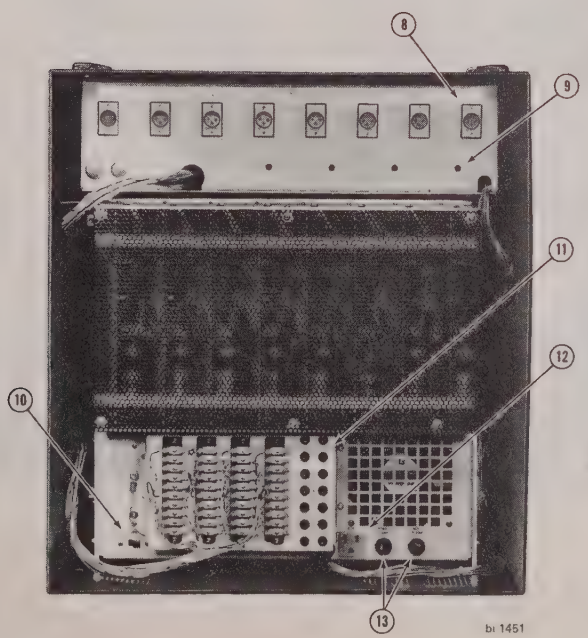


FIGURE 3-2 REAR PANEL

NOTE: Item numbers listed below correspond to circled numbers in Figure 3-3.

14 Schematic Number . . . . . This schematic number, with the revision letter indicated, must correspond with the number and revision letter of the schematic found in the rear of this manual.

15 Name Plate . . . . . Lists the complete Model number and serial number of the unit. Input voltage and frequency requirements, along with total unit power consumption are also listed.

NOTE: Always refer to unit Model number (i.e., 15-6687-01) when requesting information or service.

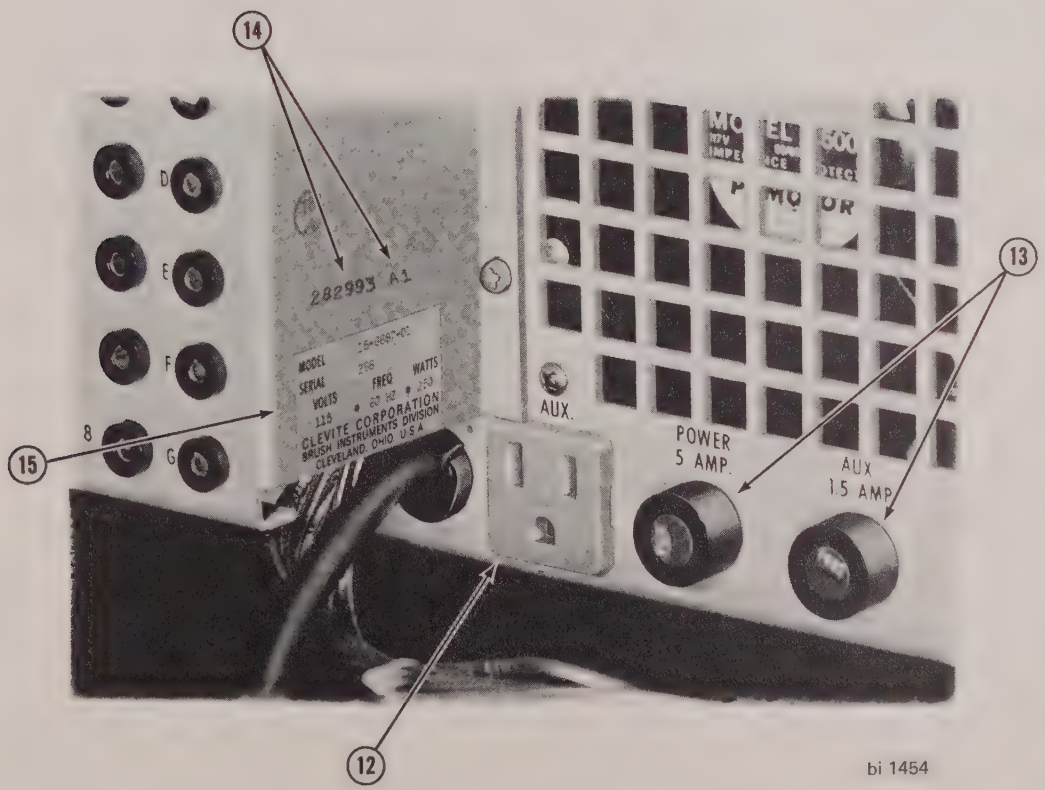


FIGURE 3-3 REAR PANEL

3.4 RECORDER SET-UP AND OPERATION

CAUTION: CHECK TO BE SURE ALL PROCEDURES IN SECTION II, INSTALLATION, HAVE BEEN PERFORMED.

When preparing the Brush 481 Recorder for operation, be sure to observe all of the following steps:

1. With unit disconnected and all signal inputs disconnected, open writing table by pulling up on pull bar (see Figure 3-1) and be sure adequate paper for operation is on supply roll, and that it is properly threaded. (See threading diagram on side of writing table). If paper supply is exhausted or improperly threaded, refer to Para. 4.2 for complete instructions on changing chart paper. Close writing table firmly.

2. Check to be sure ink valves for all pens are in full ON position.

3. Connect unit to proper voltage and frequency as indicated on unit nameplate.

4. Depress POWER switch and observe that the POWER switch button is illuminated.

5. Depress 5 MM/SEC chart speed button and operate recorder to insure good ink flow on all channels. If no writing is present after first one foot of paper, refer to Para. 4.8 and check ink cartridges for adequate ink.

6. Now connect desired analog and event signals as described in para. 2.2.

7. Set preamplifier SENSITIVITY control in OFF position.

8. Turn preamplifier SENSITIVITY X1 control to full clockwise position (detent) and secure with locking knob.

9. Position pen at exact chart center or any other desired signal-zero location with POSITION control. Lock in place.

10. Switch SENSITIVITY control to a range that will permit maximum deflection without going beyond chart edge.

11. Chart deflection will be proportional to the SENSITIVITY control setting for voltage being recorded.

12. Select a chart speed that will best display the signal with respect to recording frequency.

13. Unit is now ready for operation.

SECTION IV

MAINTENANCE

4.1 GENERAL

This section describes and illustrates removal, installation and adjustment procedures that can normally be preformed by the operator.

4.2 CHANGING CHART PAPER

This paragraph describes and illustrates the procedures for changing the chart paper.

a. Removal

1. Press chart speed STOP button.
2. Turn recorder OFF.
3. Grasp pull bar (Fig. 4-1) on bottom of writing table and pull out and up to place writing table in open position.

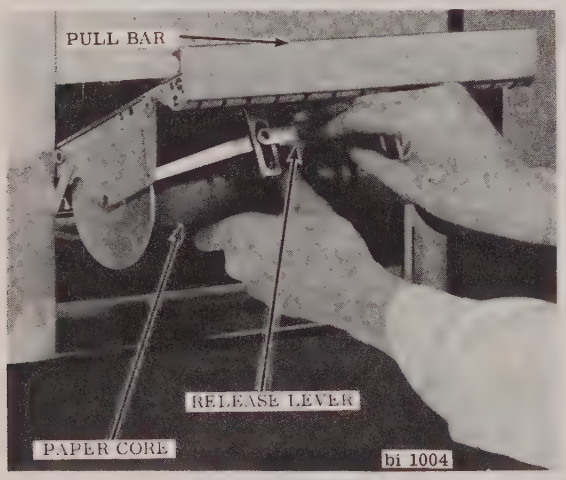


FIGURE 4-1 REMOVING PAPER SUPPLY ROLL

4. Hold paper supply roll and pull down on paper supply release lever (Fig. 4-1) and remove paper supply roll.
5. Unscrew left flange from paper supply shaft, remove and discard paper core. (Fig. 4-2)

b. Installation

1. Slide new paper roll onto paper supply shaft, making sure notches in paper core mate with guide pins in right flange. (Fig. 4-2)
2. Screw left flange onto paper supply shaft so flange is snug against paper edge.

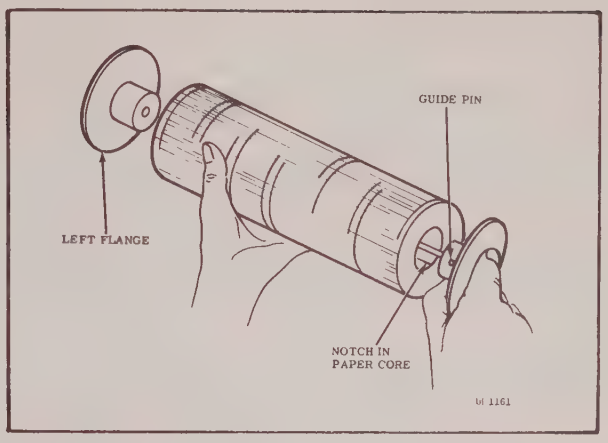


FIGURE 4-2 CHANGING CHART PAPER

3. Insert paper supply roll shaft with paper into writing table assembly (Fig. 4-3) and push up release lever to lock shaft into position.

CAUTION: CHECK TO BE SURE SHAFT IS SEATED IN WRITING TABLE ASSEMBLY AND SHAFT ROTATES FREELY.

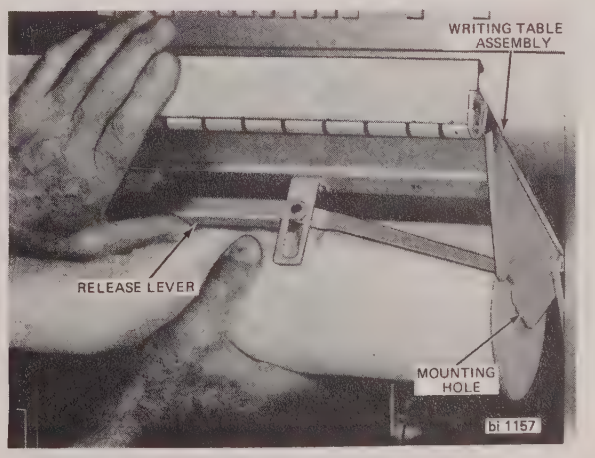


FIGURE 4-3 INSTALLING PAPER SUPPLY ROLL

4. Feed paper over writing bar, through slot in front of writing table, behind pressure roll and out front of writing table assembly (Fig. 4-4). Refer to paper threading diagram on side of writing table assembly.

CAUTION: USE CARE DURING PAPER THREADING NOT TO DAMAGE PENS.

5. Slowly close writing table assembly while gently pulling on paper. When friction resists

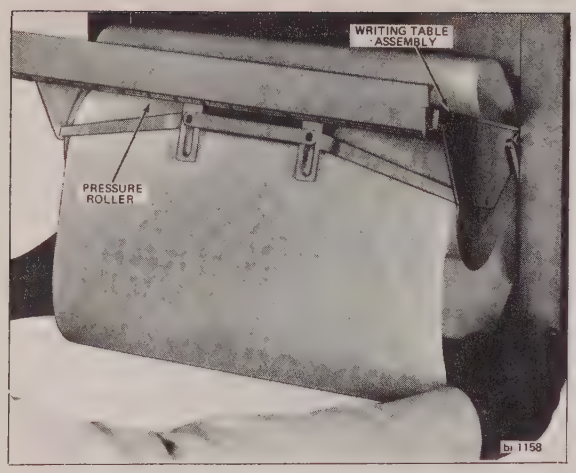


FIGURE 4-4 THREADING PAPER

rotation of paper roll, pull paper taut, center on writing table, and close writing table.

NOTE: Check to be sure writing table is properly engaged by pressing on both sides of writing table.

6. Turn recorder on and operate at 100 millimeters per second to run out about two feet of chart paper to align chart paper.

4.3 REPLACING ANALOG PEN

This paragraph describes and illustrates removal, installation and adjustment of analog pens.

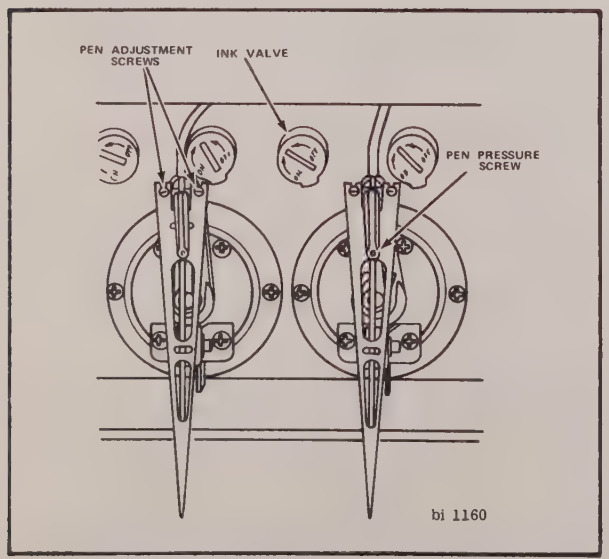


FIGURE 4-5 REPLACING PEN

NOTE: Replace and adjust only one pen at a time.

a. Removal

1. Press chart speed STOP button and turn recorder OFF.

2. Raise pen access cover by pulling out on bottom of access cover.

3. Use a flat-blade screwdriver and rotate individual ink valve button to OFF position (Fig. 4-5).

4. Use pen tube replacement tool (part number 267528) and gently remove pen ink tube from manifold nipple (Fig. 4-6).

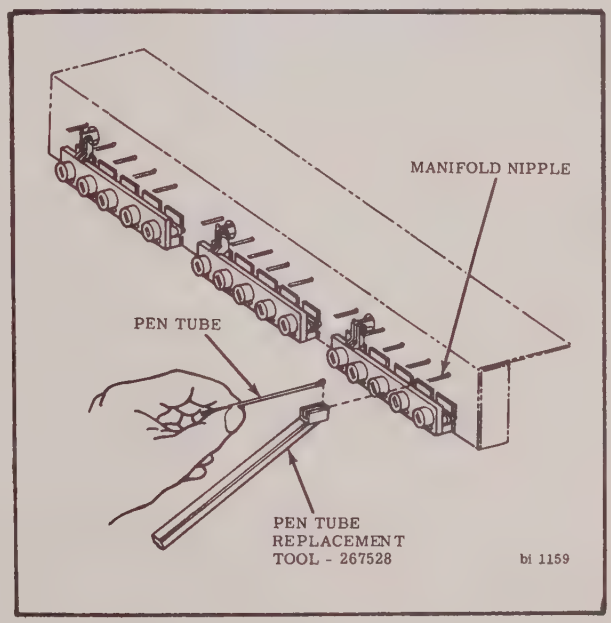


FIGURE 4-6 REPLACING PEN

5. Use pen replacement wrench (part number 1-120922-2) and loosen set screw one-half turn through access hole in side of penmotor drive-arm shaft (Fig. 4-7) and remove wrench.

NOTE: Do not loosen set screw more than one-half turn or pen cannot be removed from shaft.

6. Remove pen from penmotor drive arm shaft.

b. Installation

1. Carefully slide replacement pen onto penmotor drive arm shaft.

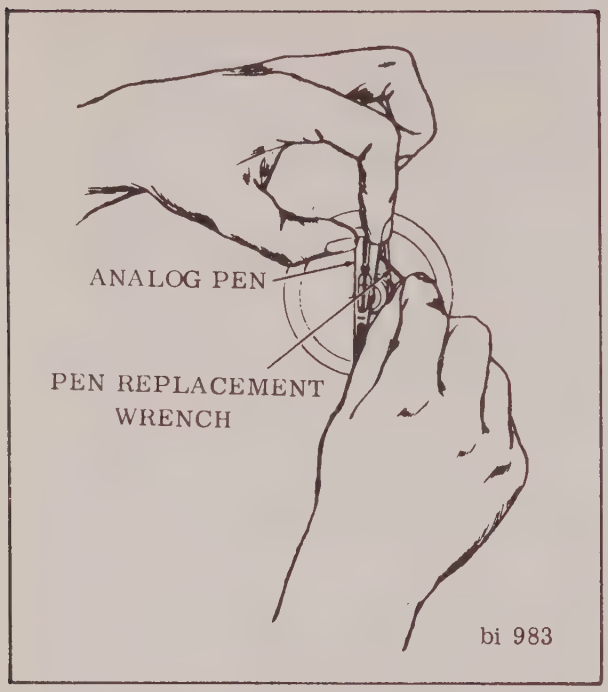


FIGURE 4-7 REPLACING ANALOG PEN

2. Align screw in pen hub with access hole in drive arm shaft and "snug up" set screw using pen replacement wrench, (part number 1-120922-2). Remove wrench.

NOTE: Set screw should be tightened to create friction, but loose enough to allow pen to be rotated in penmotor hub.

3. Install pen tube (3.3" long) between pen and manifold using pen tubing replacement tool (Fig. 4-6).

4. Use flat-blade screwdriver and turn individual ink valve to ON position.

5. Turn recorder ON, and operate recorder at 5 mm/sec.

6. Lift pen slightly to allow ink to bleed through pen tip.

7. Press recorder chart speed STOP button and turn recorder OFF.

8. Gently grasp pen near hub and move pen across entire chart width (40 mm).

9. If ink trace is not parallel to a horizontal time line, gently turn pen in penmotor drive arm until trace is parallel to time line.

10. Tighten set screw securing pen in penmotor drive arm shaft and remove wrench.

11. If pen tip is not on same time line as other analog pens, loosen two pan head adjustment screws (Fig. 4-5) and slide pen up or down until all pen tips are on the same time line, and tighten screws.

12. Check pen pressure and adjust if required. (see Para. 4.6)

NOTE: The following steps pertain to Pen, Model 11-2823-33 only. For instructions on Extended Life Pen, Model 11-2823-34, refer to Para. 4.10.

13. New pen must be lapped before proceeding. Carefully raise pen tip just enough to slide a small strip of emery paper (3M wet or dry Tri-m-ite paper, Grit M600, Brush part number 669234) under pen tip.

14. Move pen back and forth five or six times.

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

15. Remove emery paper, operate recorder at 5 mm/sec and check pen for dryness.

16. If writing is not dry, proceed with normal pen lapping as described in Para. 4.8.

17. Lower pen access cover.

4.4 REPLACING EVENT PEN (MODEL 11-2873-20)

This paragraph describes and illustrates removal and installation of the event marker pen.

a. Removal

1. Press chart speed STOP button and turn recorder OFF.

2. Raise pen access cover by pulling out on bottom of access cover.

3. Use a flat-blade screwdriver and rotate individual ink valve button to OFF position.

4. Use pen tube replacement tool (part number 267528) and gently remove pen ink tube from manifold nipple (Fig. 4-6).

5. Loosen two adjustment screws attaching pen to event marker and remove pen from event marker.

b. Installation

1. Slide replacement pen onto event marker and align pen tip on vertical grid line and on same time line as analog pens.

2. Tighten two screws attaching pen to event marker.

3. Install pen tube (4.5" long) between pen and manifold using pen tubing replacement tool (Fig. 4-6).

4. Use flat-blade screwdriver and rotate event marker ink valve button to ON position (Fig. 4-5).

5. Turn recorder ON and operate recorder at 5 mm/sec.

6. Lift pen slightly to allow ink to feed through pen tip.

7. Check pen pressure and adjust if required (Para. 4.6).

8. New pen must be lapped before proceeding. Carefully raise pen tip just enough to slide a small strip of emery paper (3M wet or dry Tri-m-ite paper, Grit M-600, Brush part number 669234) under pen tip.

9. Move emery paper up and down five or six times, parallel to division lines.

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

10. Remove emery paper, operate recorder at 5 mm/sec and check pen for dryness.

11. If writing is not dry, proceed with normal pen lapping as described in Para. 4.7.

12. Lower pen access cover.

4.5 REPLACING PENMOTOR BAND ASM

NOTE: Drive arm assembly is a non-replaceable part of the penmotor. If drive arm is broken or damaged in any way, entire penmotor must be replaced.

The penmotor band assembly (Brush part number 680294) should not be removed unless broken. Because the band tension is critical, a band replacement toll (part number 341409-915) must be used to replace band assembly.

NOTE: Penmotor need not be removed from recorder.

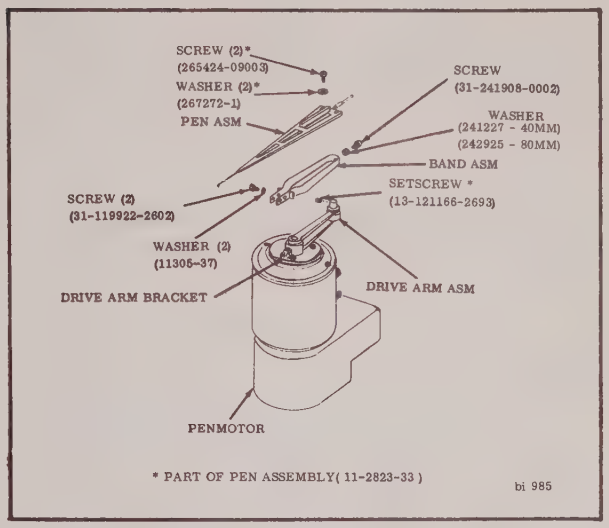


FIGURE 4-8 PENMOTOR BAND ASSEMBLY

a. Removal (Fig. 4-8)

1. Remove analog pen (Para. 4.3).

2. Remove socket-head screw and band clamping (curved) washer that secures band assembly to drive arm (use wrench 1-120922-3).

3. Remove two socket-head screws and lock washers securing band to drive arm bracket (use wrench 245218-5). Discard damaged band assembly.

CAUTION: TO PREVENT DAMAGE TO THE NEW BAND ASSEMBLY, CHECK TO BE SURE DRIVE ARM AND BRACKET ARE FREE OF NICKS, DIRT, INK BEFORE INSTALLING NEW BAND ASSEMBLY.

4. Position new band assembly around drive arm hub. Align mounting holes with tapped holes in drive arm bracket and install two screws and lock washers. Do not tighten screws.

NOTE: Check to be sure curved portion of washer is positioned to conform to the radius of the drive arm hub. Use care not to nick or scratch band assembly.

5. Carefully install band clamping washer and socket-head screw.

6. Inspect band for proper positioning around drive arm hub so that equal pressure is maintained on top and bottom of band assembly.

7. Install band tool on penmotor and thread knurled thumb screw into drive arm bracket. **(See Figure 4-9)**

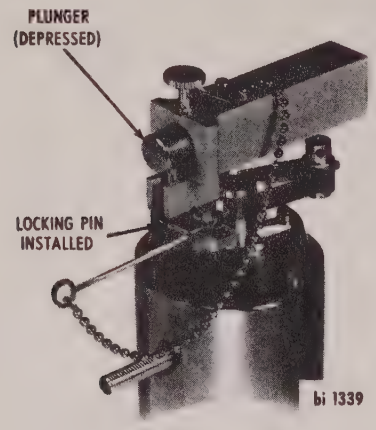


FIGURE 4-9 BAND TOOL MOUNTING

8. Depress plunger and insert locking pin into two small holes of band assembly, making certain plunger is behind locking pin.

9. Tighten two screws in drive arm bracket, loosen one quarter-turn, move drive arm back and forth several times to center band assembly and tighten screws.

10. Move drive arm back and forth several times to center band assembly on drive arm and tighten socket-head screw securing band assembly to drive arm.

NOTE: Do not tighten more than 16 inch-ounces.

11. Depress plunger and remove locking pin.

12. Loosen knurled screw securing band tool to drive arm bracket and remove tool.

13. Apply glyptal cement (or equivalent) to heads of the three screws to prevent working out.

14. Install analog pen (Para. 4.3).

4.6 PEN PRESSURE MEASUREMENT AND ADJUSTMENT

Analog or event marker pen pressure should be checked if the ink trace is excessively wide (bleeding), indicating low pen pressure or if pen gouges the chart paper, indicating excessive pen pressure.

NOTE: Wide trace may also indicate an improperly lapped pen. Refer to Paragraph 4.7 for pen lapping procedures.

The gram gage (part number 240601-910) is used to measure the pressure of the analog and event marker pen as follows:

1. Depress power on button to turn on recorder.

2. Raise pen access cover (located above writing table) by pulling out the bottom of access cover.

3. Press the 5 MM/SEC chart speed button.

4. Place gram gage hook under pen shaft as close as possible to tip and form a right angle to pen shaft with gage hook (Fig. 4-10).

5. Pull pen from chart and take reading on gage the moment excessive ink starts to flow from pen.

6. Proper writing pressure for analog pens is 28 to 32 grams. Event marker pen pressure is 20 to 25 grams.

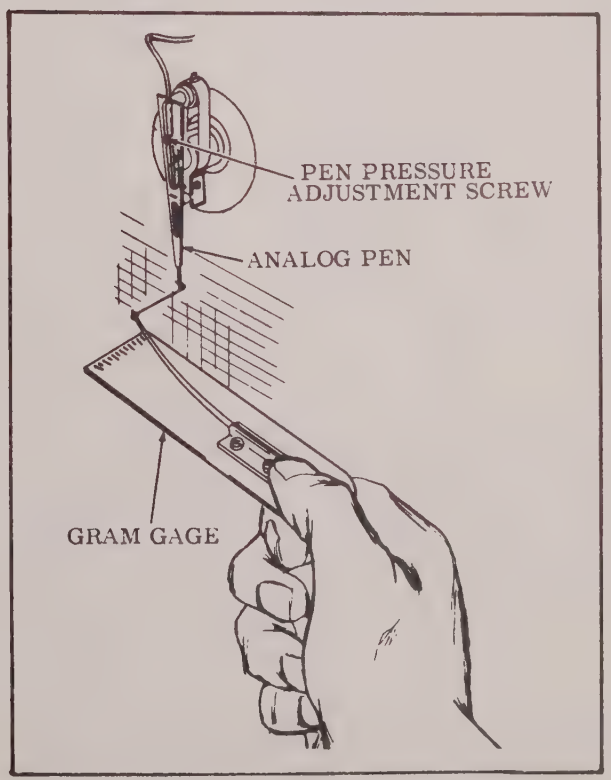


FIGURE 4-10 PEN PRESSURE MEASUREMENT

7. Use pen pressure adjustment wrench (part number 1-120922-18) and turn adjusting screw (Figs. 4-5 and 4-11) clockwise to increase pressure or counterclockwise to decrease pressure.

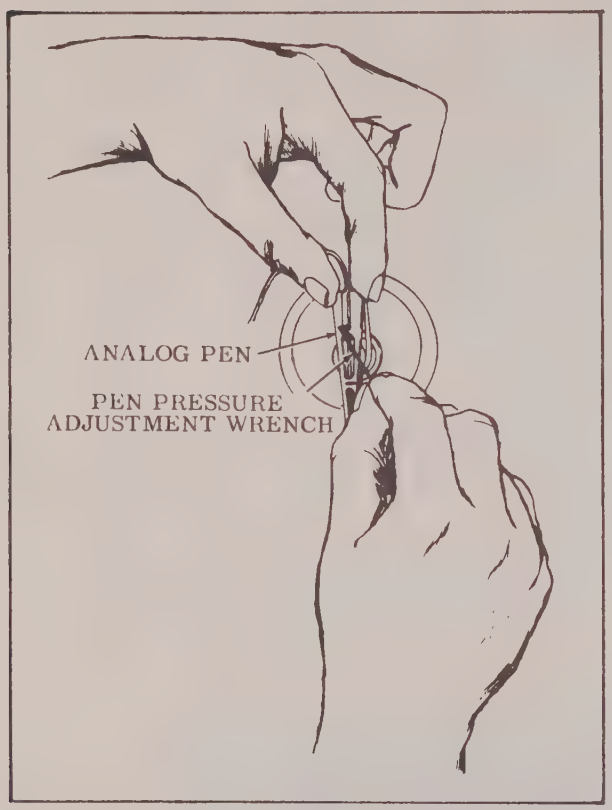


FIGURE 4-11 PEN PRESSURE ADJUSTMENT

8. Check pen pressure with gram gage and continue adjustment until proper reading is obtained.

9. If pen pressure is correct for analog and event pens, lower access cover. Recorder is ready for operation.

4.7 PEN LAPPING

NOTE: The Extended Life Analog Pen, Model 11-2823-34, must be lapped as described in Para. 4.10.

a. General

This paragraph describes and illustrates the proper procedures for lapping the analog and event pens. Intermittent or "wet" ink trace are indications that pen pressure is incorrect or that pen requires lapping. Check for "wet" writing by operating the recorder at five mm/sec chart speed, (no signal applied). Check pen trace by wiping index finger, with moderate pressure, across trace approximately one inch below pen tip. If ink does not smear, pen is properly lapped. If trace smears, check and adjust pen pressure (Para. 4.6.). Repeat test, and if trace continues to smear, lapping is required.

b. Lapping Procedure

NOTE: Lapping of pens should only be done when required.

1. Turn recorder off.

2. Raise pen access cover by pulling on bottom of access cover.

3. Carefully raise pen tip just enough to slide a small strip of emery paper (4/0) under pen tip. (Brush part number 141119) (see Fig. 4-12).

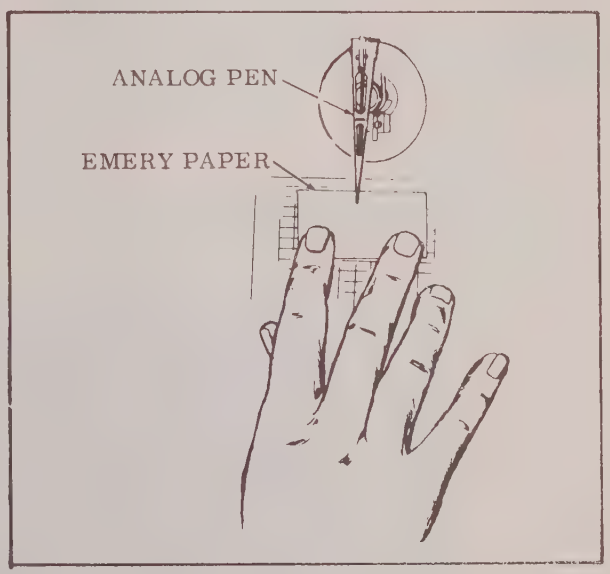


FIGURE 4-12 PEN LAPPING

CAUTION: DO NOT USE A COARSE OR VERY ABRASIVE TYPE OF EMERY PAPER. USE ONLY THE GRADE SPECIFIED.

4. Move pen back and forth for a total distance of approximately two inches.

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

5. Remove emery paper, operate recorder at 5 mm/sec and check pen trace for dryness.

6. Repeat steps 3 thru 5 as required to obtain dry trace.

7. If pen tip should become blocked during lapping operation, touch pen at top of pen (above tip) with a hot soldering iron for a few seconds with the pen tip raised slightly off the paper. This will usually start ink flowing and flush out abrasive.

NOTE: If procedure is repeated more than three times, recheck pen pressure and repeat lapping. Strict adherence to above lapping procedures is imperative.

8. When dry trace is achieved, lower access cover.

4.8 INK CARTRIDGE REPLACEMENT

This paragraph describes and illustrates the procedures for replacing ink cartridges, Model 11-2730-01.

a. Removal

WARNING: CHECK TO BE SURE RECORDER IS TURNED OFF AND DISCONNECTED FROM POWER SOURCE.

1. Recorder must be removed from case, Model No. 11-1115-30 or slid out of rack when using Kit, Model No. 11-1202-20. To remove unit from case, rest recorder on either side, and remove four rubber feet, two at front edge and two at center of case. Now remove four front panel screws and slide recorder forward out of the case. To slide recorder from a rack, remove four front panel screws and slide recorder forward.

2. Remove top cover by removing four pan-head screws. (Fig. 4-13).

3. Turn activating screw clockwise until compression spring in ink plunger has been drawn up tight into ink plunger assembly and ink flow stopped.

4. Remove two screws (see Fig. 4-14) securing mounting bracket to support bar.

5. Raise ink plunger assembly free of unit.

6. Carefully remove ink tube from ink cartridge being careful not to drop ink tube back inside recorder.

7. Unscrew ink cartridge from plunger assembly and discard cartridge

b. Installation

1. Remove and discard piston retainer from replacement cartridge (see Fig. 4-15).

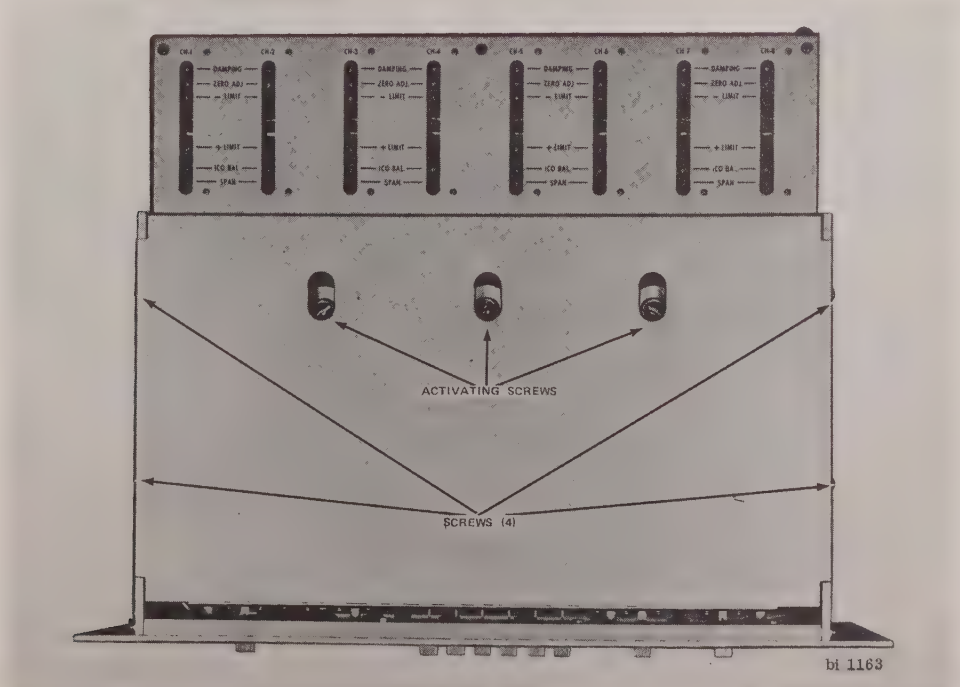


FIGURE 4-13 REPLACING INK CARTRIDGE

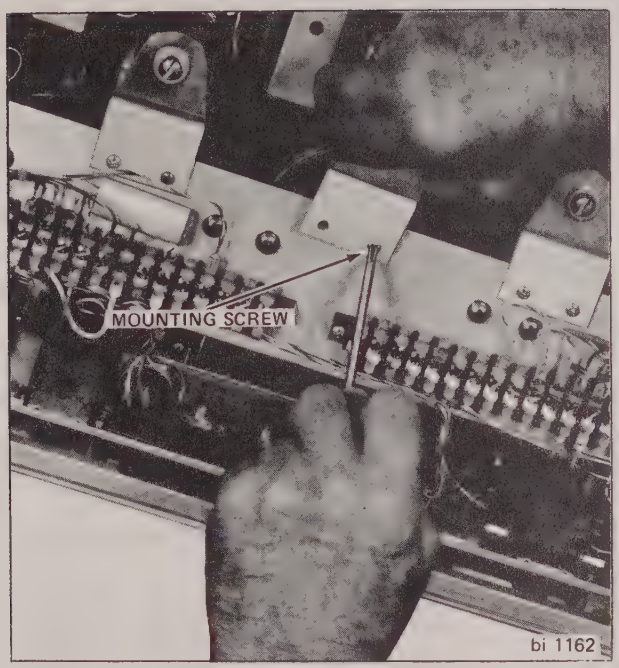


FIGURE 4-14 REPLACING INK CARTRIDGE

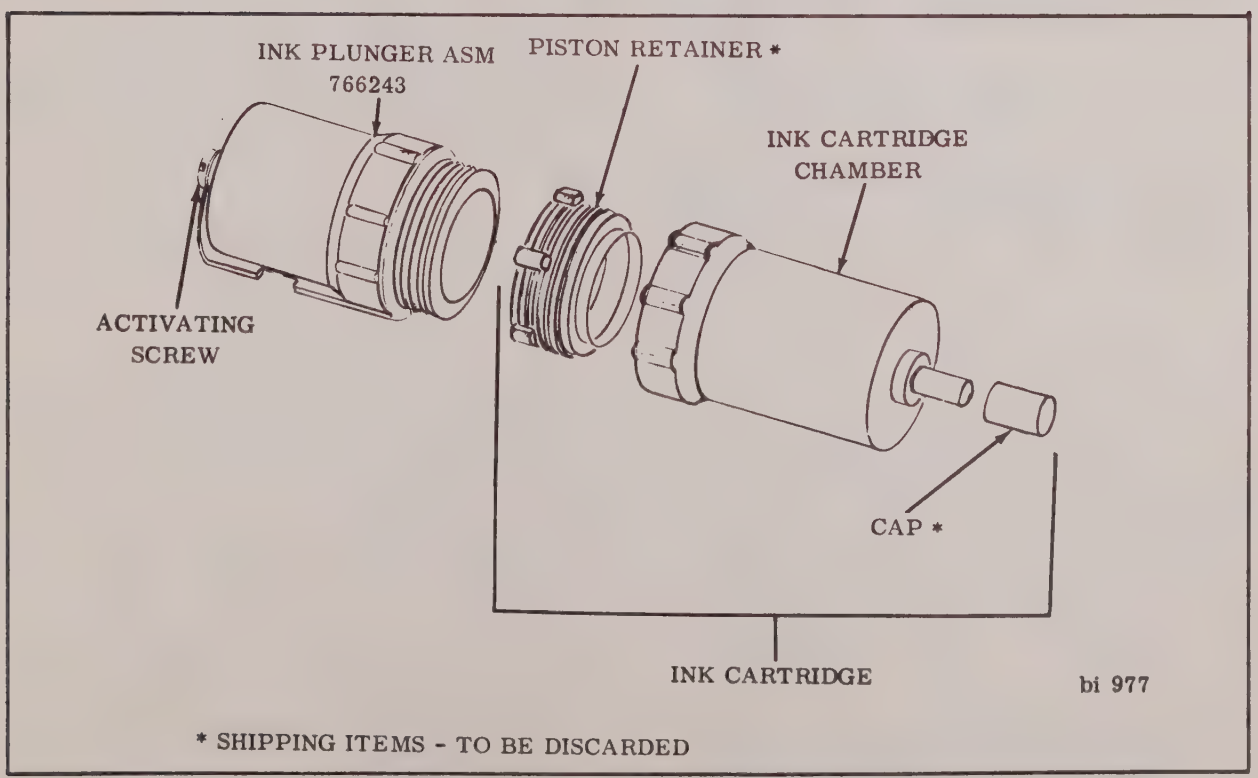


FIGURE 4-15 REPLACING INK CARTRIDGE

2. Install ink cartridge on plunger assembly and tighten securely.

3. Remove and discard shipping cap from ink cartridge.

4. Install ink tube on cartridge.

NOTE: Do not use tweezers or other sharp instruments to install tubing.

5. Carefully lower ink plunger assembly into unit and secure using two screws removed in step a.3 above.

6. Turn activating screw counterclockwise until snug to pressurize ink system.

7. This completes the ink cartridge replacement procedure.

8. Install top cover by installing four pan-head screws.

9. Recorder should now be installed in portable case or in rack using hardware removed in step a.1 above.

4.9 PEN CLEANING

In the event that a pen should fail to write or displays intermitten writing, it may be caused by a clogged pen. The procedure outlined below is intended as a guide to flush pens, but may not always prove effective.

1. Turn recorder off.

2. Close ink valve on affected channel.

3. Remove ink tubing from manifold (Fig. 4-6).

4. Remove pen (Para. 4.3a or 4.4a).

NOTE: Do not remove tubing from pen unless tubing is kinked or suspected of being defective.

5. Modify No. 18 hypodermic needle per Figure 4-16.

6. Attach modified needle onto 2cc hypodermic syringe.

7. With syringe plunger depressed, insert needle in pen tubing.

8. Immerse pen tip in cleaning agent (Isopropyl Alchohol, Cell-O-Solve or equivalent).

9. Back-flush by slowly withdrawing syringe plunger.

NOTE: It may be necessary to allow the pen to remain for a brief period in the cleaning agent to dissolve dried ink at pen tip.

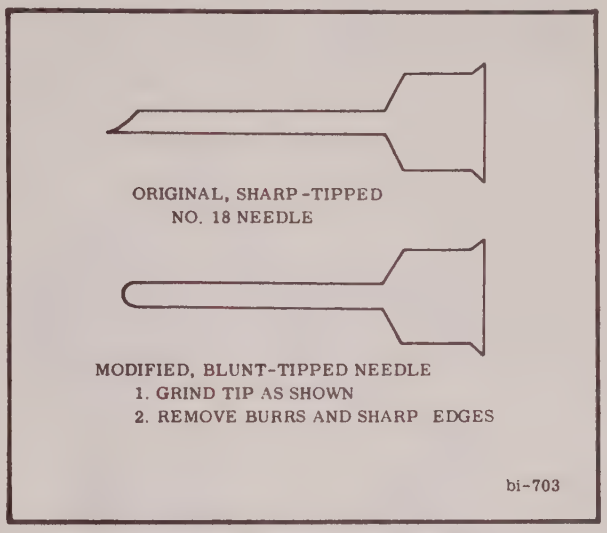


FIGURE 4-16 HYPODERMIC NEEDLE MODIFICATION

10. Install pen (Para. 4.3b or 4.4b).

NOTE: Clogging of pens occurs only when proper adjustment, operation and/or handling as per Brush Operating Manual has not been adhered to.

4.10 LAPPING PROCEDURES FOR EXTENDED LIFE PEN, MODEL 11-2823-34

The Bruh Model 11-2823-34 Extended Life Pen requires a different lapping procedure from that described in Para. 4.7. Install pen as described in Para. 4.3, but disregard lapping instructions referred to.

Lap Extended Life Pen as follows:

1. Raise pen access cover.

2. Shut off ink manifold knobs of all channels by rotating all knobs counterclockwise.

3. Raise writing table and rewind chart paper so that no paper is left under pen tips. Be sure sufficient paper is on roll to energize interlock switch to permit recorder operation.

4. Now set pen pressure to 30 grams against writing bar.

5. Place coarser of two lapping papers supplied (Brush part number 668965) under pen tip and drive pen at 60 Hz, 1/2 of full scale.

6. Simultaneously move lapping paper back and forth under pen. Lap in this manner for 90 seconds.

7. Now repeat procedure using finer lapping paper (Brush part number 668963) for 90 seconds.

8. Return recorder to normal operating condition (thread chart paper over writing bar and turn ink control knobs on).

NOTE: In most cases, one lapping will suffice, but occasionally two or three will be required to effect a proper seal.

9. If pen tip should become blocked during lapping operation, touch pen at top of bend (above tip) with a hot soldering iron for a few seconds with pen tip slightly raised off paper. This will usually start ink flowing and flush out abrasive.

10. Lower pen access cover.

4.11 SCHEMATICS

Before attempting electrical troubleshooting of the Brush 481, check to be sure the schematic number and revision letter stamped on rear of unit corresponds with schematic and revision letter found at the rear of this manual.

Model No	Schematic
15-6687-01	282993
15-6687-06	283224

SECTION V

THEORY OF OPERATION

5.1 GENERAL

The Brush 481 Recorder consists of eight analog channels, associated penmotor drive amplifiers and power supplies (Fig. 5-1). The input signal to each channel is balanced–to–guard.

Penmotor drive amplifier is a complete servo-type system utilizing a Metrisite Transducer in the penmotor to develop position and a Tachometer Generator to derive velocity.

5.2 DRIVE AMPLIFIER NETWORK ASM 869223

a. Regulated D.C. Power Supply Circuit (Fig. 5-2)

Primary power to each channel is applied to transformers T-301 thru T-308 and rectified by full wave rectifier bridge, CR-215. The common output point of transformers, T-301 thru T-308, is tied to ground. The output voltages, plus and minus 32 volts D.C. are applied to the output stages of the drive amplifier. Regulated plus and minus 18 volts D.C. to preamplifier and to amplification stages of drive amplifier are derived from resistors R-230 and R-231, and zener diodes CR-209 and CR-210. Regulated minus 5.6 volts, derived from resistor, R-245, and zener diode, CR-208, and regulated plus 5.6 volts, an output of oscillator A-201, are applied to pen POSITION control, R-302.

b. Drive Amplifier and A.C. Feedback Circuit (Fig. 5-2)

The drive amplifier acts as an error amplifier in that the input signal is constantly compared with pen position and assures that pen position on the chart accurately displays the input signal.

The summing of the amplifier is at the input of amplifier IC-201. The input signal is summed thru resistor, R-218. The demodulated signal from the position sensing transducer (Metrisite) is summed thru resistor R-226. Resistor, R-225, serves as a summing resistor for the zero adjustment current thru ZERO control, R-223. Resistor, R-228, serves as the open-loop feedback path for the amplifier. Resistor, R-227, sums the velocity feedback signal

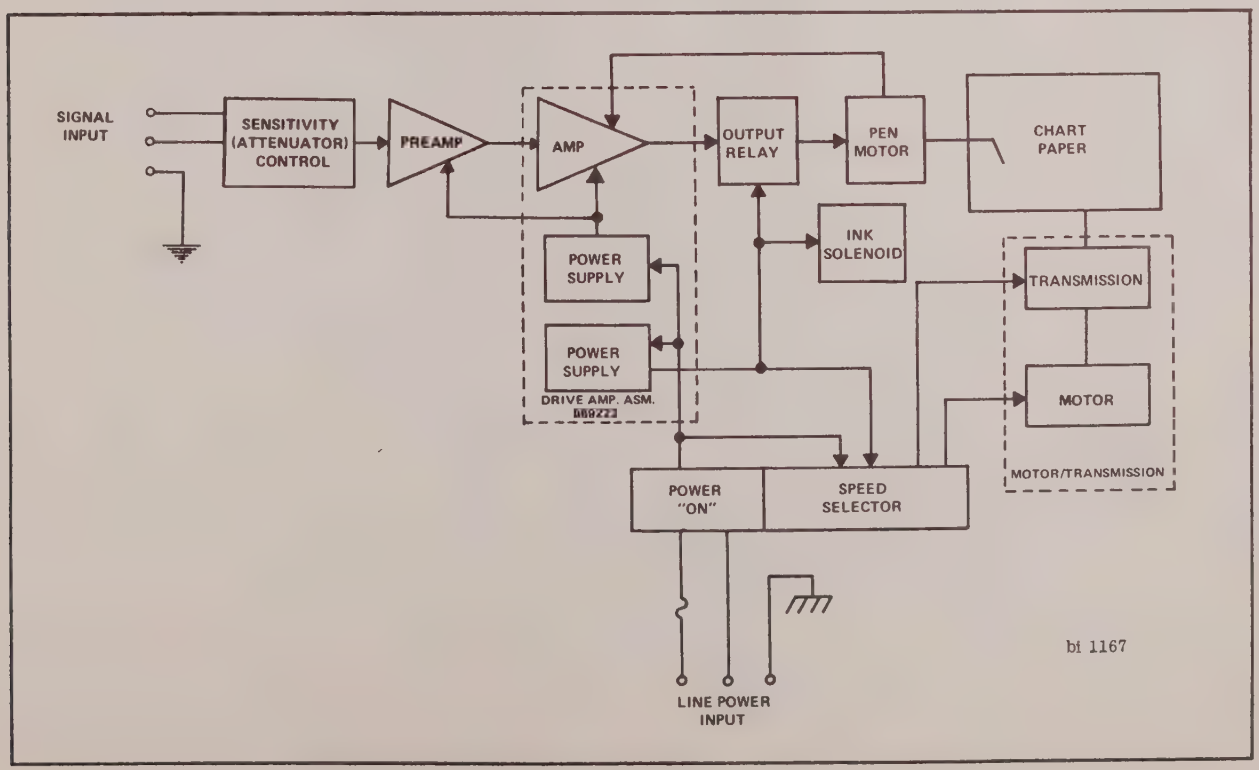


FIGURE 5-1 FUNCTIONAL BLOCK DIAGRAM

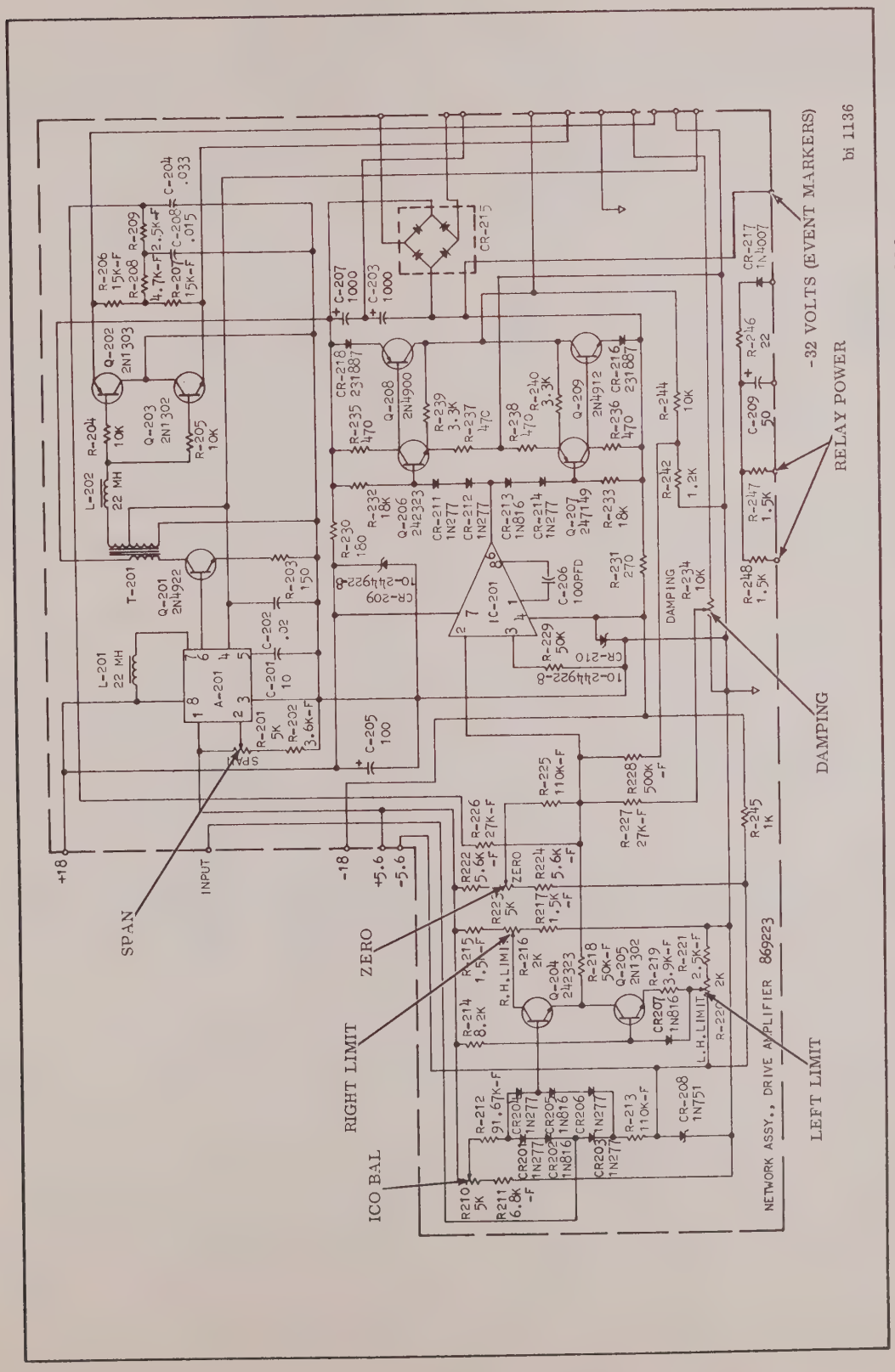


FIGURE 5-2 AMPLIFIER AND POWER SUPPLIES NETWORK ASSEMBLY 869223

which is derived from a tachometer generator within the penmotor. DAMPING control, R-234, permits adjustment for optimum frequency response and waveform reproduction. Any error voltage is amplified by amplifier, IC-201, transistors, Q-206 and Q-207, which form a phase-splitting driver stage for the output transistors, Q-208 and Q-209.

c. Left and Right Limiter Circuit (Fig. 5-2)

The output of the preamplifier is applied to the base of an emitter-follower transistor, Q-204, through diode network CR-201, CR-202, CR-203, CR-204, CR-205 and CR-206. The diode network provides the necessary bias and temperature compensation to assure a stable output from the limiters. Transistor Q-205 functions as a current source and emitter load for transistor Q-204. RIGHT LIMIT adjust, R-216, and LEFT LIMIT adjust, R-220, limit the voltage swing of transistor Q-204 which instantaneously clips any excess voltage applied to the limiters.

d. 20 KHz Oscillator and Demodulator Circuits (Fig. 5-2)

Oscillator, A-201, contains the 20 KHz circuit. Amplitude adjustment is provided by applying a variable D.C. voltage from variable resistor, R-201, to terminal 2 of the module. An additional terminal (pin 4) is provided to allow additional components to be added to oscillator control loop.

The oscillator output voltage is amplified by transistor, Q-201 and further stepped up by transformer, T-201, which has a tapped secondary winding providing two outputs. One output (tap) is applied to primary of position-sensing transducer (Metrisite). This same output is applied to Oscillator, Q-201, to correct for any change in output amplitude from transformer, T-201.

The second output voltage of transformer, T-201 is applied thru reactor, L-202, (phase-shifting coil) to the phase-sensitive demodulator consisting of transistors, Q-202 and Q-203, and resistors R-204 and R-205.

The varing output voltage from the Metrisite is then applied to the demodulator circuit across resistors, R-202 and 207. The demodulated and filtered output of the Metrisite circuit is then applied to the error amplifier thru resistor, R-226.

5.3 SENSITIVITY (ATTENUATOR) CONTROL & PREAMPLIFIER CIRCUITS (Fig. 5-3)

Input signals are applied to the balanced attenuator network consisting of resistors R-101 thru R-126. The differential input signal from the attenuator network is applied to the input of the preamplifier module, AR-401, thru protective resistors, R-401 and R-402.

With the variable SENSITIVITY control (R-410/S-410) in the detent (X1) position, the preamplifier assembly operates at a gain of 100 which is set by resistor, R-403. The variable SENSITIVITY control places a portion of resistor, R-403, and varies the gain down to 40. The single-ended output of the preamplifier assembly is applied to the drive amplifier thru the limiter circuit.

Pen position voltage, from the wiper arm of POSITION control, R-419 is applied to a reference terminal of preamplifier module, AR-401.

SECTION VI

CALIBRATION

6.1 GENERAL

The Brush 481 Recorder has been factory calibrated, and under normal conditions will not require calibration. However, because of parts replacement or repair, calibration may be necessary. This section describes and illustrates the correct calibration procedures. It should be pointed out that calibration should only be performed by qualified personnel familiar with procedures and standards.

6.2 TEST EQUIPMENT REQUIRED

The following is a list of recommended test equipment necessary for calibration.

NOTE: Specific manufacturer need not be adhered to, but comparable equipment is mandatory, since accuracy stated is imperative.

a. Function Generator (Hewlett-Packard, Model 202A, or equivalent).

b. D.C. Power Supply, 0 to 5 volts ±0.1% (floating).

NOTE: A precision voltmeter (Fluke 883A or equivalent) may be used to monitor D.C. Power Supply to insure accuracy if precision D.C. Power Supply is not available.

6.3 CALIBRATION PROCEDURE

NOTE: Procedure outlined is typical of all channels.

1. Remove unit from case (Para. 4.3) or slide unit forward out of rack to expose calibration controls (Fig. 6-1).
2. Connect unit to proper power source as indicated on unit nameplate.
3. Depress POWER ON on pushbutton and allow a fifteen minute warm-up-time.
4. Set pen to exact chart center with pen POSITION control.
5. Remove the four (4) screws and lockwashers which secure the Event Marker Input Panel to the chassis (Refer to Fig. 3-2).
6. Depress the 5MM/SEC chart speed button. Disconnect preamplifier signal output by carefully removing the coaxial lead (both conductor and shield) from the two (2) spade lugs corresponding to channel to be calibrated.
7. Connect one end of test clip lead to HI lug of terminal strip.
8. Alternately open and short HI and LO lugs together.
9. Adjust ICO BAL (Balance) control for minimum pen movement when opening and shorting terminals.
10. Clip HI and LO lugs together.
11. Center pen by adjusting ZERO control located on amplifier board.
12. Remove test clip lead and reconnect coaxial cable.
13. Turn SENSITIVITY control to OFF position.

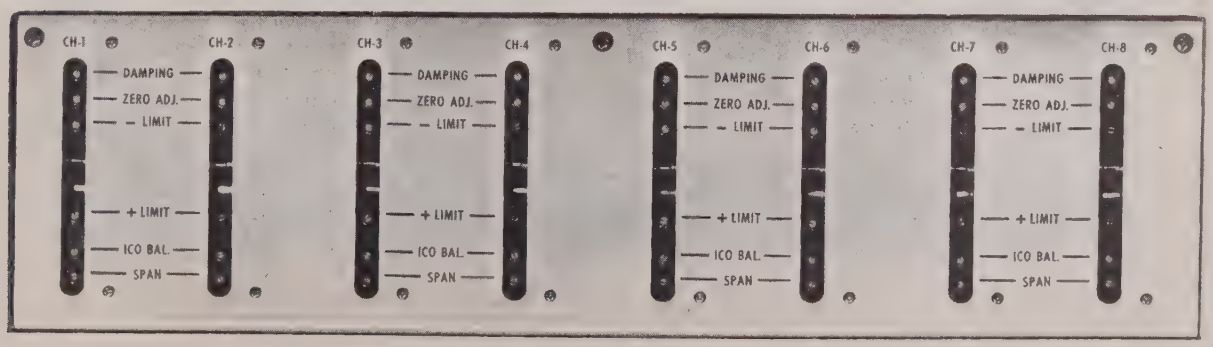


FIGURE 6-1 CALIBRATION CONTROLS

14. Continue to operate recorder at chart speed of five millimeters per second.

15. Verify that pen is at exact chart center; if not, use pen POSITION control and set pen at exact chart center.

16. Rotate variable SENSITIVITY X1 control throughout its entire range several times and check for any pen deflection.

17. If no pen deflection is observed, preamplifier is properly balanced.

18. If observed pen deflection is greater than 1/4 division, adjust preamplifier BALANCE control for no pen deflection while rotating SENSITIVITY X1 control throughout its entire range.

NOTE: Refer to Figure 6-2. Balance controls for channels 1 through 8 are accessible through holes in rear panel.

19. Set SENSITIVITY control to 100 mv/div position.

20. Apply ±2.5 V d-c ±0.1% to input terminals. Adjust SPAN control for exactly ±25 divisions of pen deflection. (Fig. 6-1)

NOTE: If input signal will be primarily square wave, perform steps in 6.4. If input singal will be primarily sine wave, perform steps in 6.5 (page 6.3).

6.4 SQUARE WAVE FREQUENCY RESPONSE

21. Apply a 1 Hz squarewave of 25 divisions peak-to-peak amplitude. Adjust DAMPING control for best wave-from reproduction.

22. Check frequency response by applying a 10 Hz square wave 10 divisions peak-to-peak. Increase frequency to 100 Hz; amplitude response must remain flat (± 1 division). Increase frequency to 125 Hz; amplitude should be 7 divisions. Adjust DAMPING control if necessary.

23. Apply a 4 Hz square wave, 50 divisions peak-to-peak. Increase frequency to 40 Hz. Amplitude should remain flat at 50 divisions, ± 1 division.

24. Apply positive 3 volts d-c to input and adjust LEFT LIMIT control to bring pen 1-½ to 2 divisions beyond chart edge.

25. Apply negative 3 volts d-c to input and adjust RIGHT LIMIT control to bring pen 1-½ to 2 divisions beyond chart edge.

This completes unit calibration. Depress chart STOP button and disconnect all test equipment. Replace unit in case (Para. 4.3) or slide unit into rack. Unit is ready for operation.

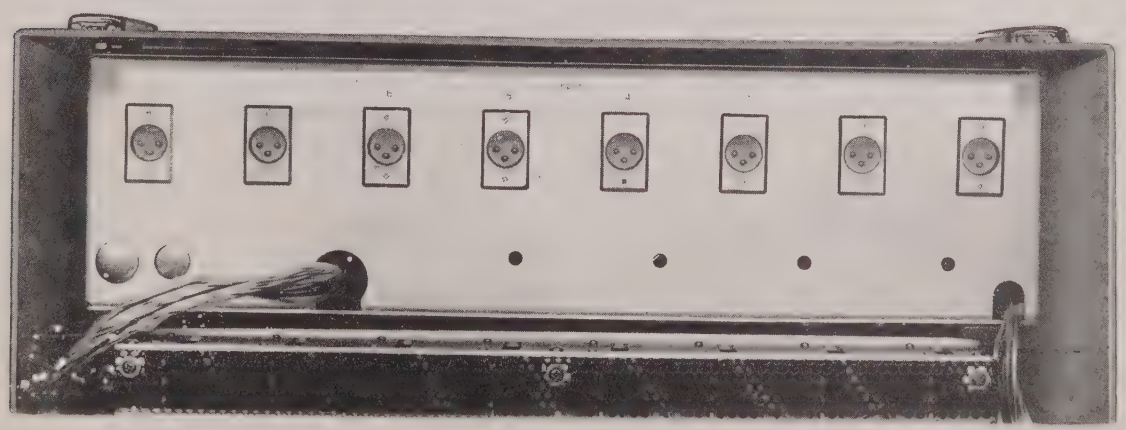


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FIGURE 6-2 PREAMPLIFIER BALANCE CONTROLS

6.5 SINE WAVE FREQUENCY RESPONSE

21. Apply a 1 Hz sine wave of 25 divisions peak-to-peak amplitude. Adjust DAMPING control for best wave-form reproduction.

22. Check frequency response by applying a 10 Hz sine wave 10 divisions peak-to-peak. Increase frequency to 100 Hz; amplitude response must remain flat (± 1 division). Increase frequency to 125 Hz; amplitude should be 7 divisions. Adjust DAMPING control if necessary.

23. Apply a 4 Hz sine wave, 50 divisions peak-to-peak. Increase frequency to 40 Hz. Amplitude should remain flat at 50 divisions, ± 1 division.

24. Apply positive 3 volts d-c to input and adjust LEFT LIMIT control to bring pen 1-½ to 2 divisions beyond chart edge.

25. Apply negative 3 volts d-c to input and adjust RIGHT LIMIT control to bring pen 1-½ to 2 divisions beyond chart edge.

SECTION VII

PARTS IDENTIFICATION

7.1 GENERAL

This recorder has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Brush Service Engineer listed on the warranty card shipped with the recorder.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the recorder.

NOTE: Check to be sure the schematic number and revision letter stamped on the rear of the recorder agree with the number and revision letter on the schematic contained in this section.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name, model number, and serial number of the instrument.

   For example: Brush 481 Recorder, Model 15-6687-01, Serial Number

2. Description of the part as listed in the manual

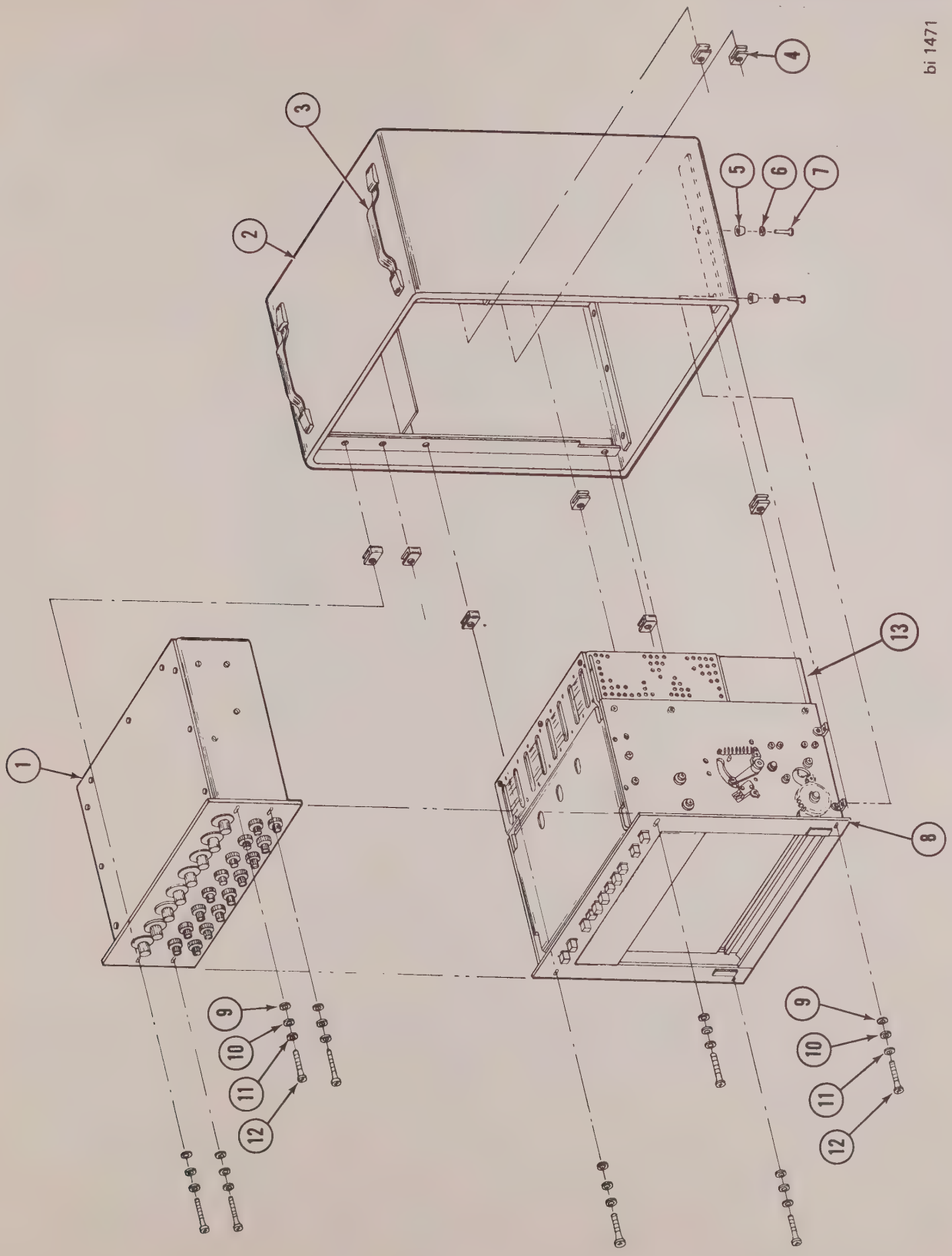
3. Brush part number

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

BRUSH 481 RECORDER
EXPLODED VIEW PARTS LIST FIGURE 7-1

ITEM NO.	PART NUMBER	DESCRIPTION	
1	883148	Preamplifier Assem. *	(Figure 7-12)
2	11-1115-31	Case Assem.	
3	243485	Handle	
4	245244-02	Nut - Floating	
5	120903-221	Bumper	
6	1-216741-420	Lockwasher	
7	31-119918-6210	Screw, Pan Head	
8	15-6687-00	Recorder Assem.	(Figure 7-2)
9	128967-1	Washer	
10	126138-9	Washer	
11	31-120650-10	Washer	
12	31-121534-0216	Oval Head	
13		Chassis Assy*(Figure 7-13)	

*Completed assemblies not available. See detail figures for individual pieces.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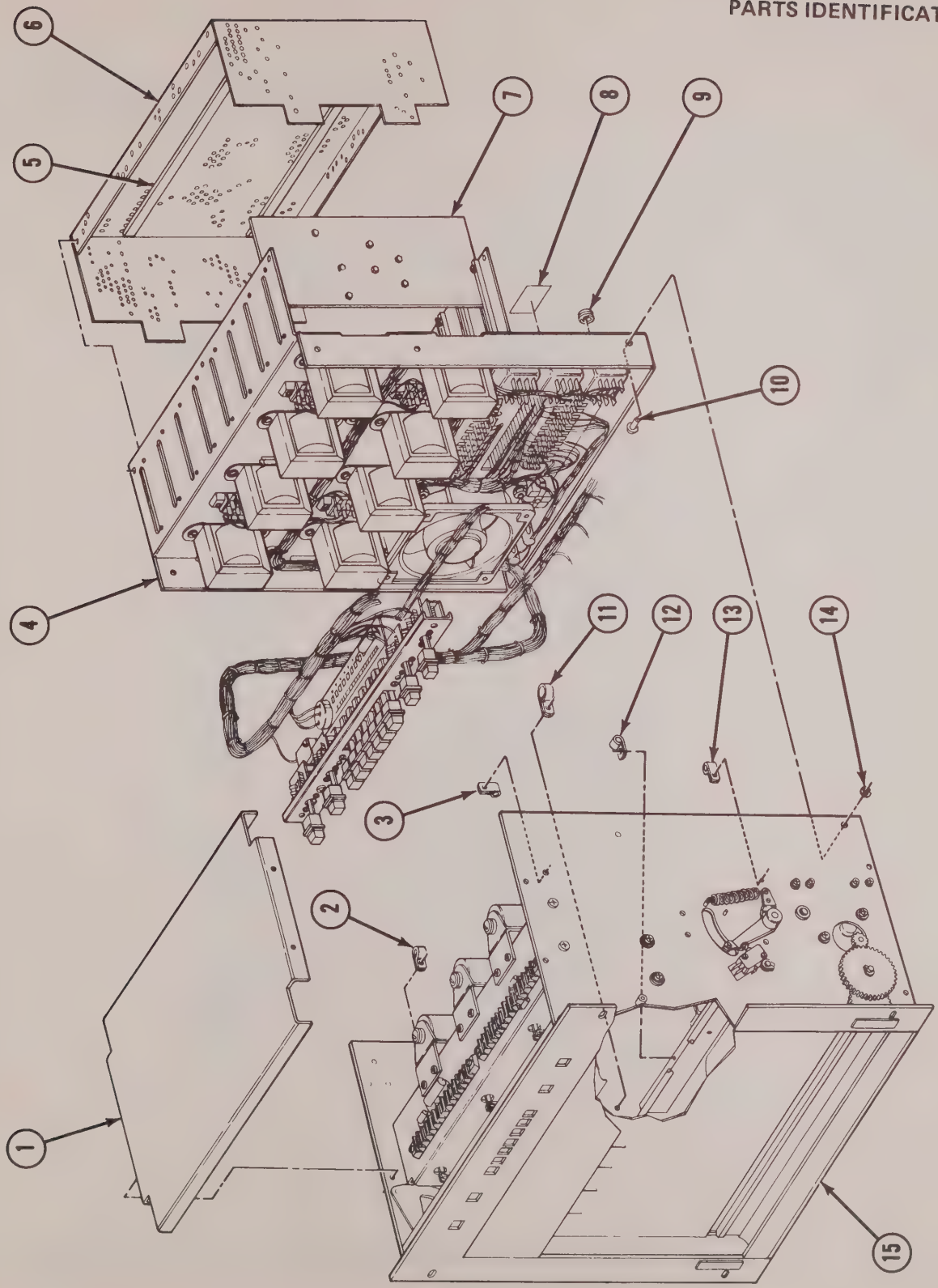
BRUSH 481 RECORDER
EXPLODED VIEW PARTS LIST - FIGURE 7-2

ITEM NO	PART NUMBER	DESCRIPTION
1	869736	Cover, Top
2	232660-5	Clamp, Loop
3	232660-4	Clamp, Loop
4	869677	Chassis Asm. Electrical (See Figure 7-10)* (-01 only)
4	869883	Chassis Asm. Electrical (See Figure 7-10)* (-06 only)
5	230820-1	Plastic, Open Cell
6	369589	Cover
7	869223	Network Asm. Drive Amp (See Figure 7-11)
8	465913-25	Plate, Identification (-01 only)
8	465913-164	Plate, Identification (-06 only)
9	130970-4	Bushing, Electrical
10	243440	Bumper
11	232660-8	Clamp, Loop
12	232660-4	Clamp, Loop
13	232660-7	Clamp, Loop
14	1-127657-5	Ring, Retaining
15	869675	Chassis Asm. Mechanical (See Figure 7-3)* (-01 only)
15	869885	Chassis Asm. Mechanical (See Figure 7-3)* (-06 only)

*Completed assemblies not available. See detail figures for individual pieces.



RECORDER ASSEMBLY
FIGURE 7-2

EXPLODED VIEW PARTS LIST
MECHANICAL CHASSIS ASM 869675 (-01)
MECHANICAL CHASSIS ASM 869885 (-06)
FIGURE 7-3

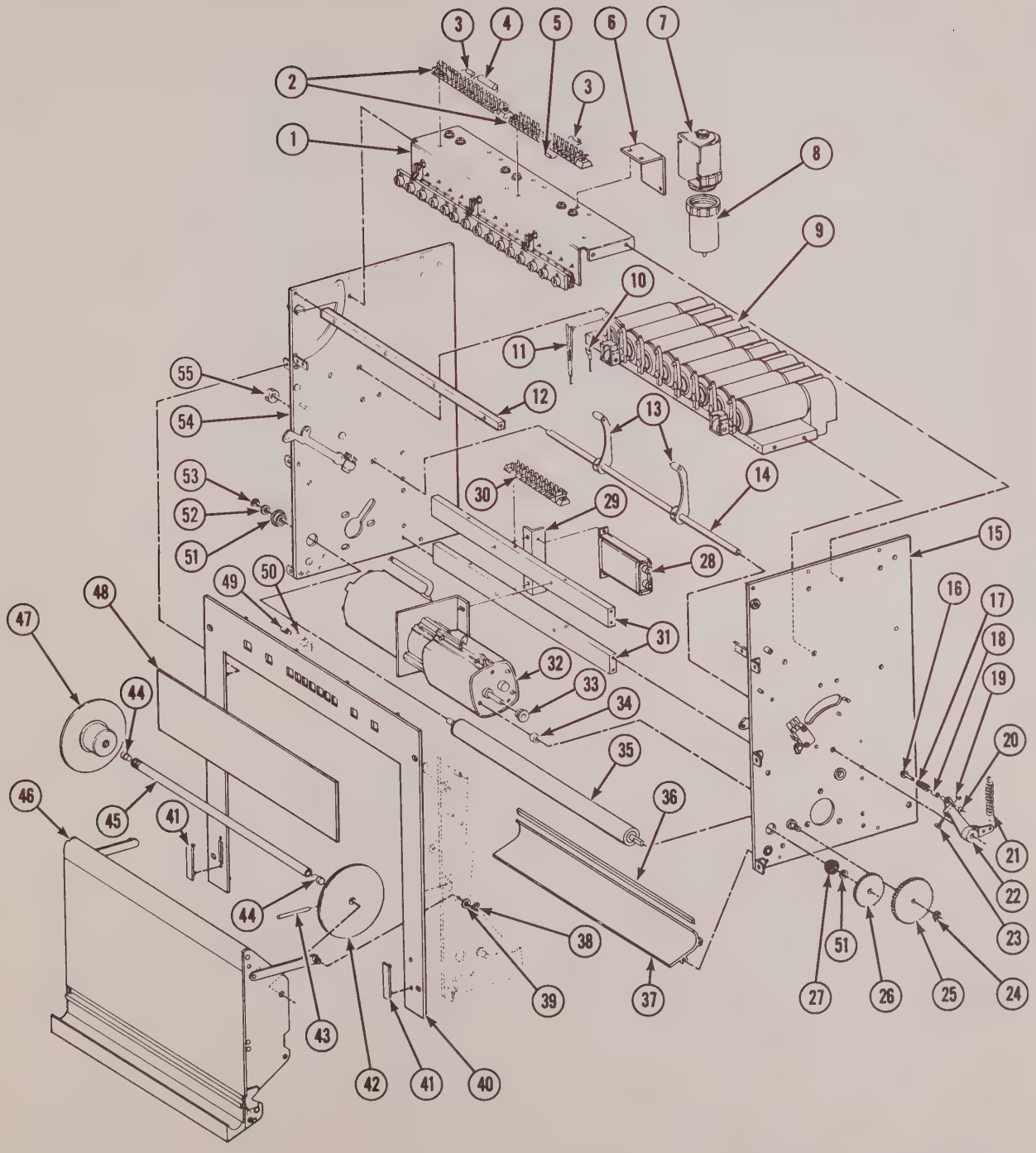
ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	869478	Manifold Asm (Figure 7-8)	
2	265814-15	Terminal Board	TB-310, 311
3	10-241145-224	Capacitor	C-301, 302
4	10-261998-824	Capacitor	C-303
5	231887	Semiconductor, VT-910	CR-301
6	349487	Bracket, Ink Supply	
7	766243	Ink Plunger Asm	
8	11-2730-01	Ink Cartridge Asm	
9	869476	Penmotor Shield Asm (See Figure 7-6)*	
10	11-2873-20	Pen Asm, Event	
	666587-1	Tubing, Event Pen (Not Shown)	
11	11-2823-33	Pen Asm, Analog	
	666587-4	Tubing, Analog Pen (Not Shown)	
12	269488	Bar Support	
13	743915-10	Arm Asm, Sensor	
14	269484	Shaft	
15	869445	Plate Asm, RH (See Figure 7-5)*	
16	643919-10	Disc Asm, Friction	
17	269291	Spring Compression	
18	263376	Insulation, Sleeve	
19	31-129647-62	Nut, Hex	
20	0-240731-2	Washer, Retainer	
21	243457	Spring, Helical	
22	743913-10	Arm Subasm, Brake	
23	31-119924-6208	Screw, Machine, Hex Head	
24	1-227070-9	Ring, Retaining	
25	269491	Gear, Dual	
26	269499	Gear, Spur	
27	265741-1	Bearing, Ball	
28	127852	Capacitor	C-304

*Completed assemblies not available. See detail figures for individual pieces.

EXPLODED VIEW PARTS LIST (continued)
MECHANICAL CHASSIS ASM 869675 (-01)
MECHANICAL CHASSIS ASM 869885 (-06)
FIGURE 7-3

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
28	263870-505	Capacitor (-06)	C-304
	230014	Bracket, Capacitor (-06)	
29	269536	Bracket, Angle	
30	265814-10	Terminal Board	TB-309
31	369490	Bar, Mounting	
32	869496 (-01)	Drive Asm (See Figure 7-9)*	
32	869882 (-06)	Drive Asm (See Figure 7-9)*	
33	269498	Gear, Spur	
34	248102	Spacer, Motor	
35	669481	Roll, Drive	
36	269494	Deflector, Paper	
37	769492	Chute, Paper	
38	1-227070-9	Ring, Retaining	
39	127271	Washer	
40	869442	Panel Subasm, Front	
41	246388	Cover, Panel	
42	769475	Flange Asm, RH	
43	1-119820-815	Pin, Groove	
44	280159	Bearing, Insert	
45	269480	Shaft, Supply	
	769474	Shaft Asm (Not Shown, Includes Items 42, 43, 44 and 45)	
46	869452	Table Asm, Writing (See Figure 7-7)*	
47	769472	Flange Asm, LH	
48	782967	Cover Asm	
49	128327	Lamp	DS-301
50	266063	Lampholder	
51	265741-1	Bearing, Ball	
52	127271	Washer	
53	2-240731-10	Ring, Retaining	
54	869449	Plate Asm, LH (See Figure 7-4)*	
55	243443	Collar, Shaft	

*Completed assemblies not available. See detail figures for individual pieces.



MECHANICAL CHASSIS ASM
FIGURE 7-3

EXPLODED VIEW PARTS LIST
PLATE ASM, LEFT HAND 869449 - FIGURE 7-4

ITEM NO	PART NUMBER	DESCRIPTION
1	243898-82	Nut, Assembled
2	869450	Side Plate Sub, LH
3	128967-1	Washer, Plain
4	267464	Hinge, LH
5	247659	Screw
6	269495	Spring, Positioning
7	243622	Pad, Friction
8	243611-910	Lever Asm, LH
9	127271	Washer
10	243507	Button, Detent
11	1-265849-4	Bracket, Angle
12	1-127657-5	Ring, Retaining
13	243440	Bumper
14	1-227070-9	Ring, Retaining
15	240161-310	Pin, Straight
16	267479	Button
17	242217-5	Catch, Ball

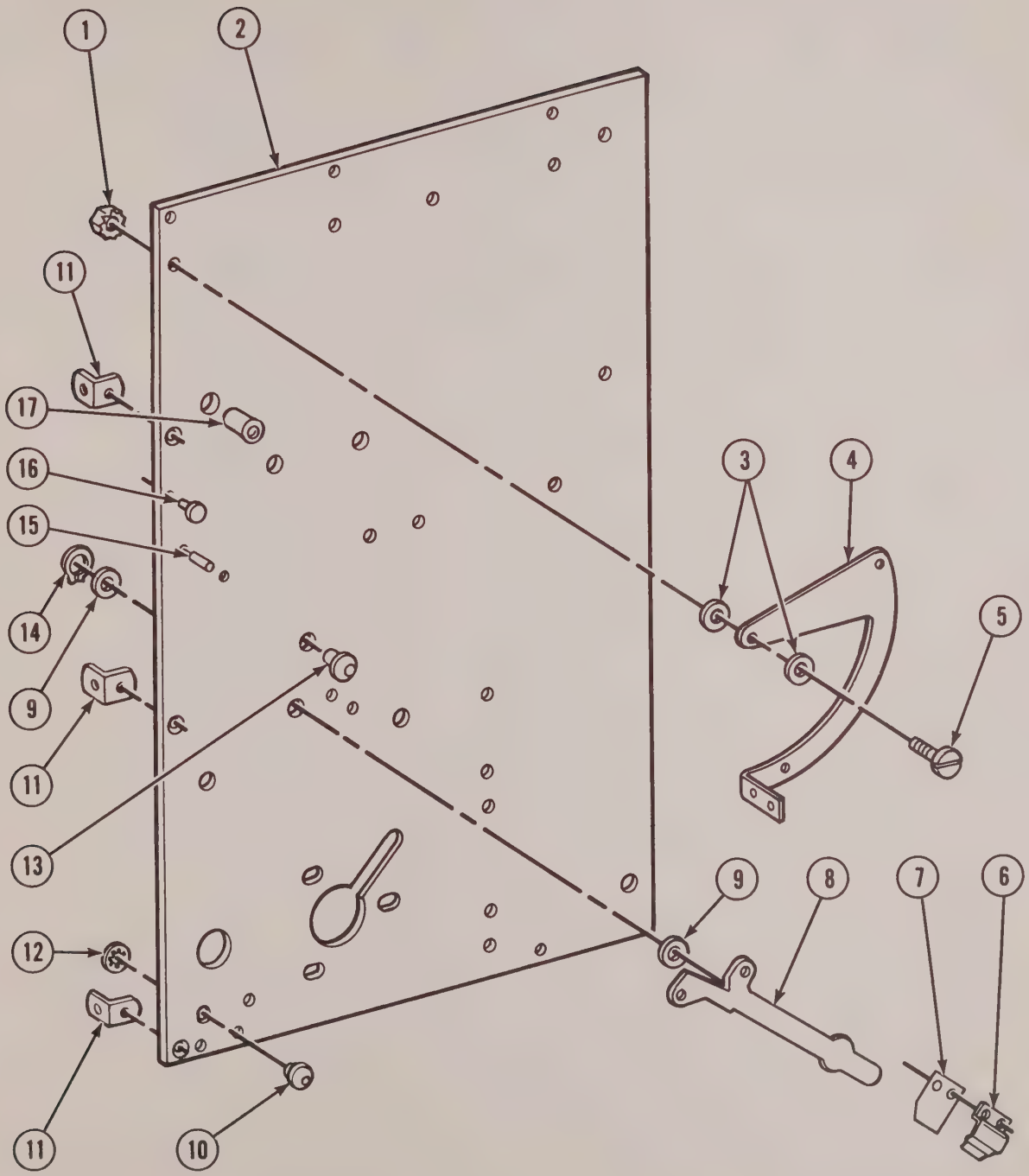


PLATE ASM, LEFT HAND 869449
FIGURE 7-4

EXPLODED VIEW PARTS LIST
PLATE ASM, RIGHT HAND 869445 - FIGURE 7-5

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	269495	Spring, Positioning	
2	243622	Pad, Friction	
3	247659	Screw	
4	128967-1	Washer, Plain	
5	267466	Hinge, RH	
6	242217-5	Catch, Ball	
7	243898-82	Nut, Assembled	
8	469447	Plate, Side RH	
9	127271	Washer	
10	1-227070-9	Ring, Retaining	
11	265874-1	Pin	
12	4-112468-7	Pin Roll	
13	130970-4	Bushing, Elec	
14	269467	Insulator, Microswitch	
15	266326	Switch, Sensitive	S-309
16	269448	Shaft, Idler	
17	1-127657-5	Ring, Retaining	
18	1-265849-4	Bracket, Angle	
19	243507	Button, Detent	
20	243898-82	Nut, Assembled	
21	240161-310	Pin, Straight	
22	267479	Button	
23	665789	Lever Asm, RH	

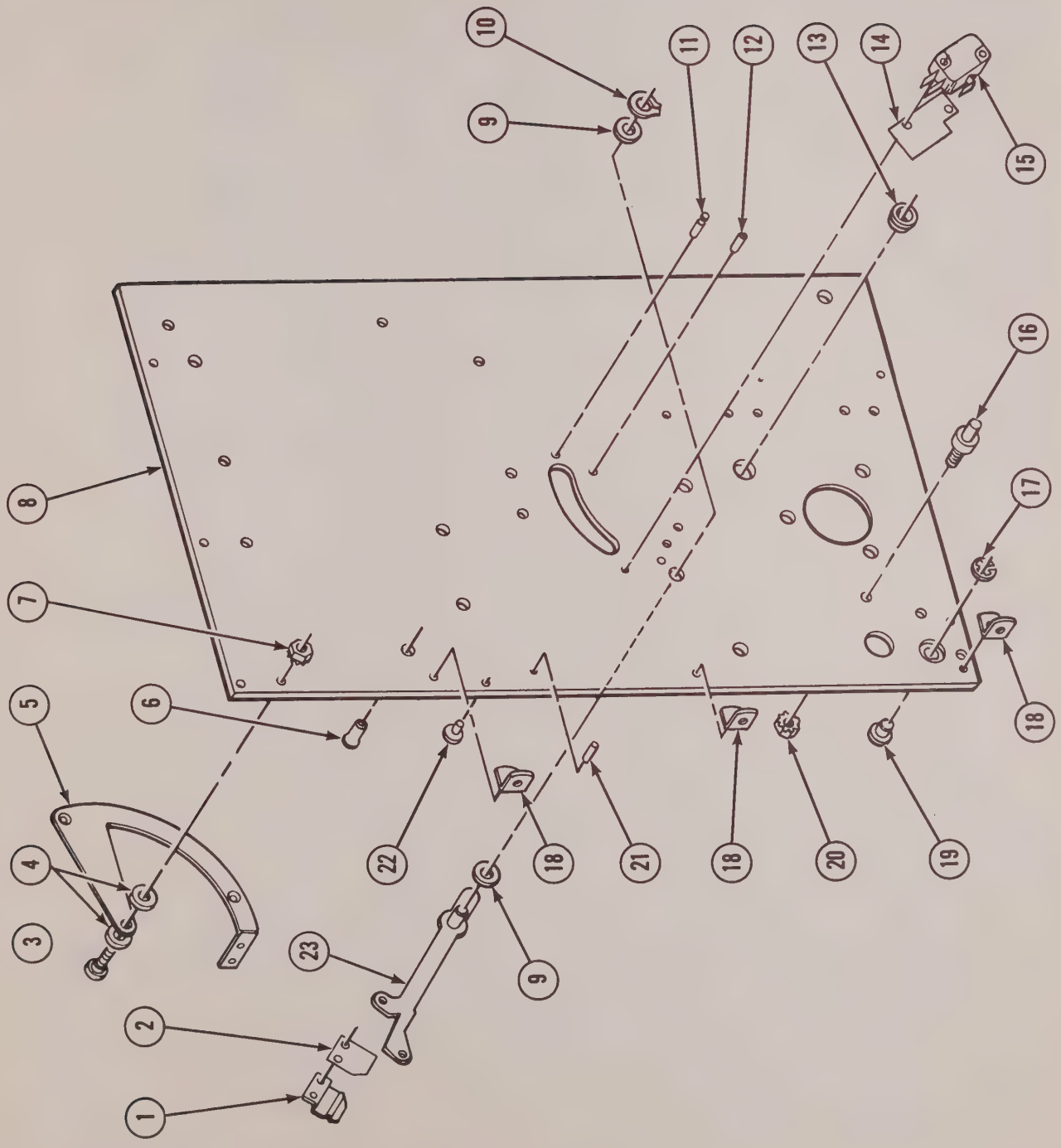
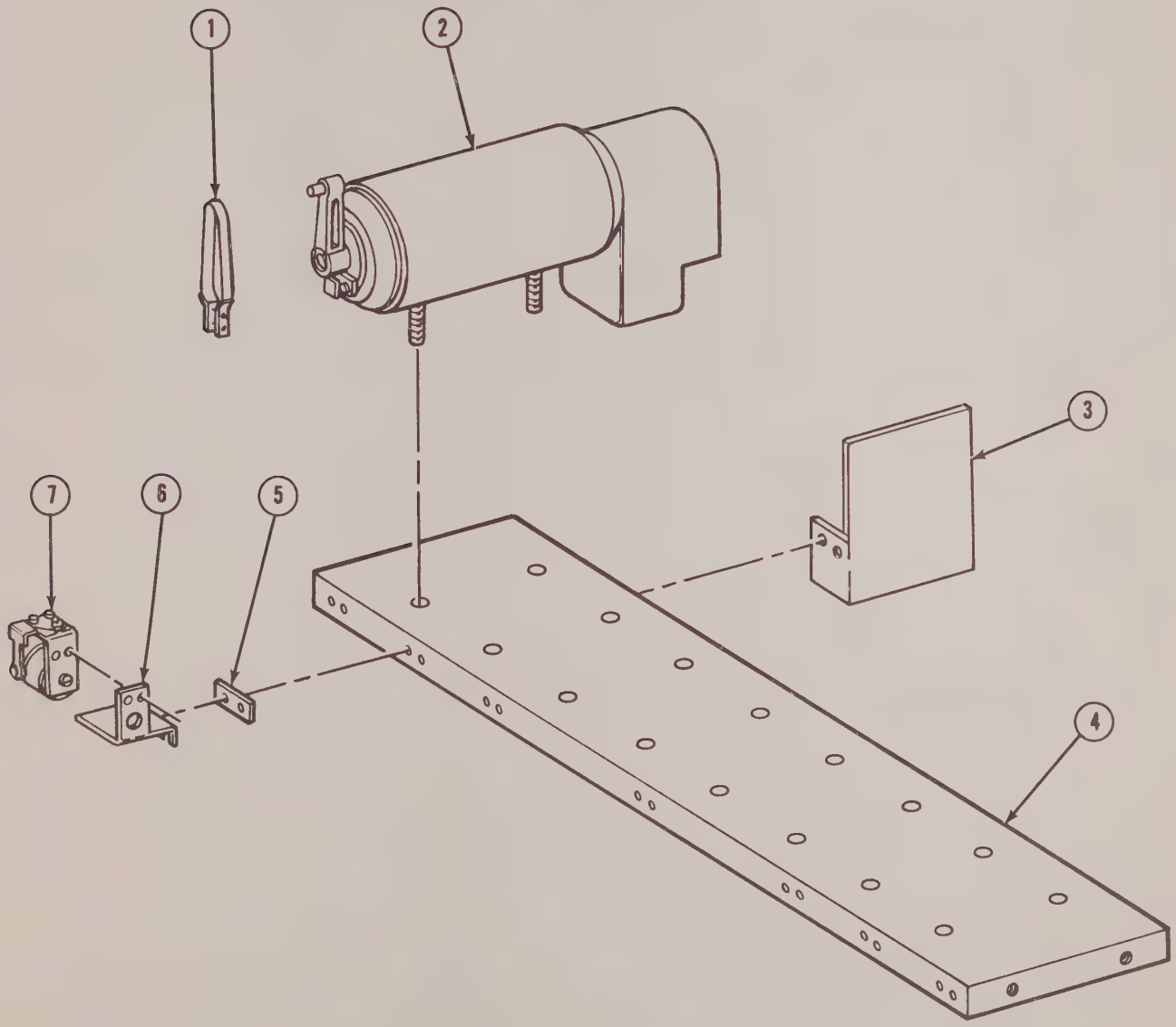


PLATE ASM, RIGHT HAND 869445
FIGURE 7-5

EXPLODED VIEW PARTS LIST
PENMOTOR SHIELD ASM 869476 - FIGURE 7-6

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	680294	Drive Band Asm	
2	867060	Penmotor Asm (includes Item 1)	M-301 thru M-308
3	266871	Shield	
4	469477	Bar Mtg, Penmotor	
5	280050	Spacer	
6	267189	Bracket	
7	11-2123-32	Event Marker Asm, RH	



PENMOTOR SHIELD ASM 869476
FIGURE 7-6

EXPLODED VIEW PARTS LIST
TABLE ASM, WRITING 869452 - FIGURE 7-7

ITEM NO	PART NUMBER	DESCRIPTION
1	769464	Support Asm, Left
2	869456	Table Subasm
3	769454	Bar Writing
4	369458	Support Table
5	769469	Paper Release Asm
6	2-214148-102	Pin, Dowel
7	769459	Support Asm, Right
8	4-112468-9	Roll Pin
9	243855-1	Catch Ball
10	769468	Bar Subasm, Pull
11	265597-1	Bearing, Ball
12	369485	Roll, Pressure
13	243867-1	Packing, Preformed

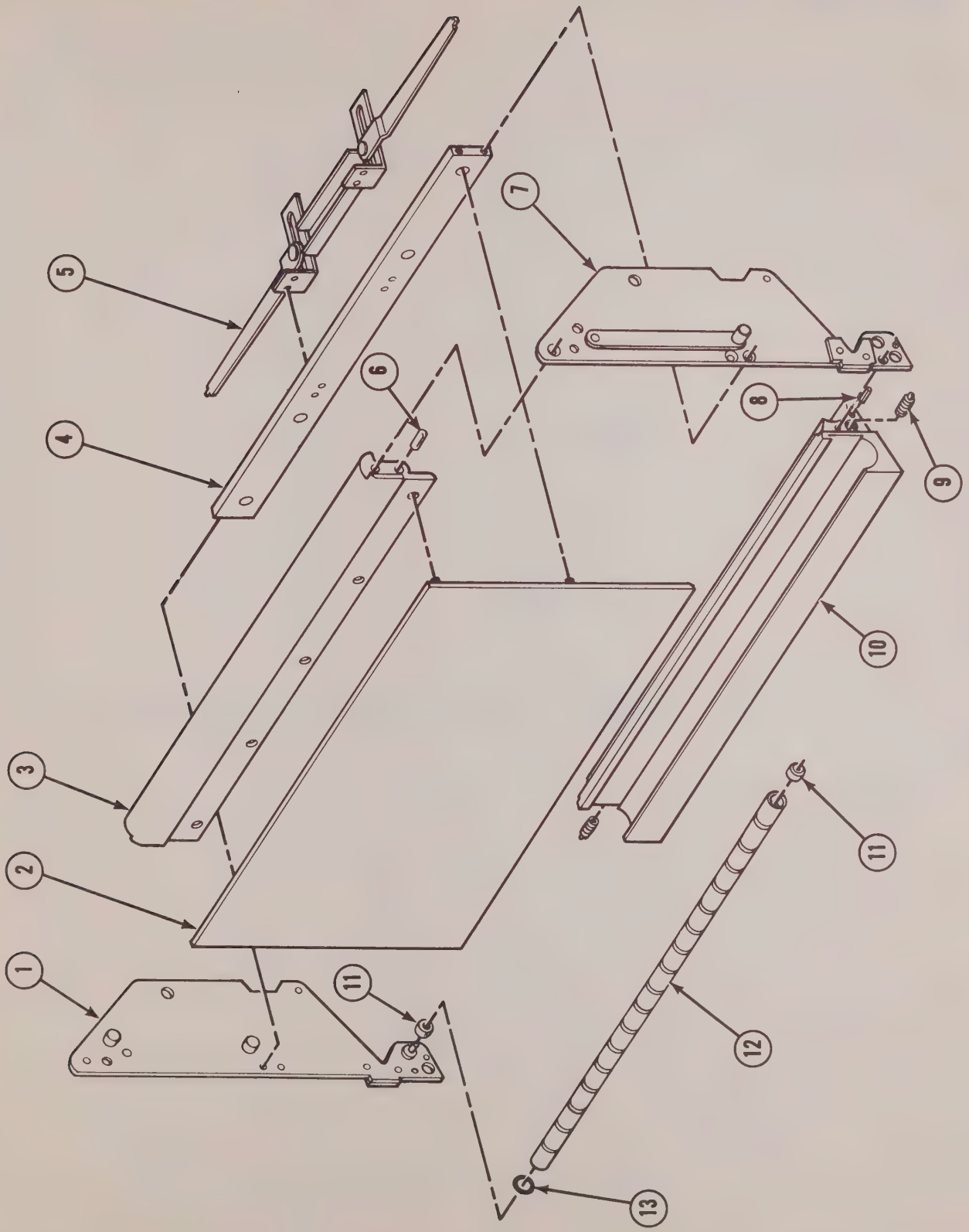
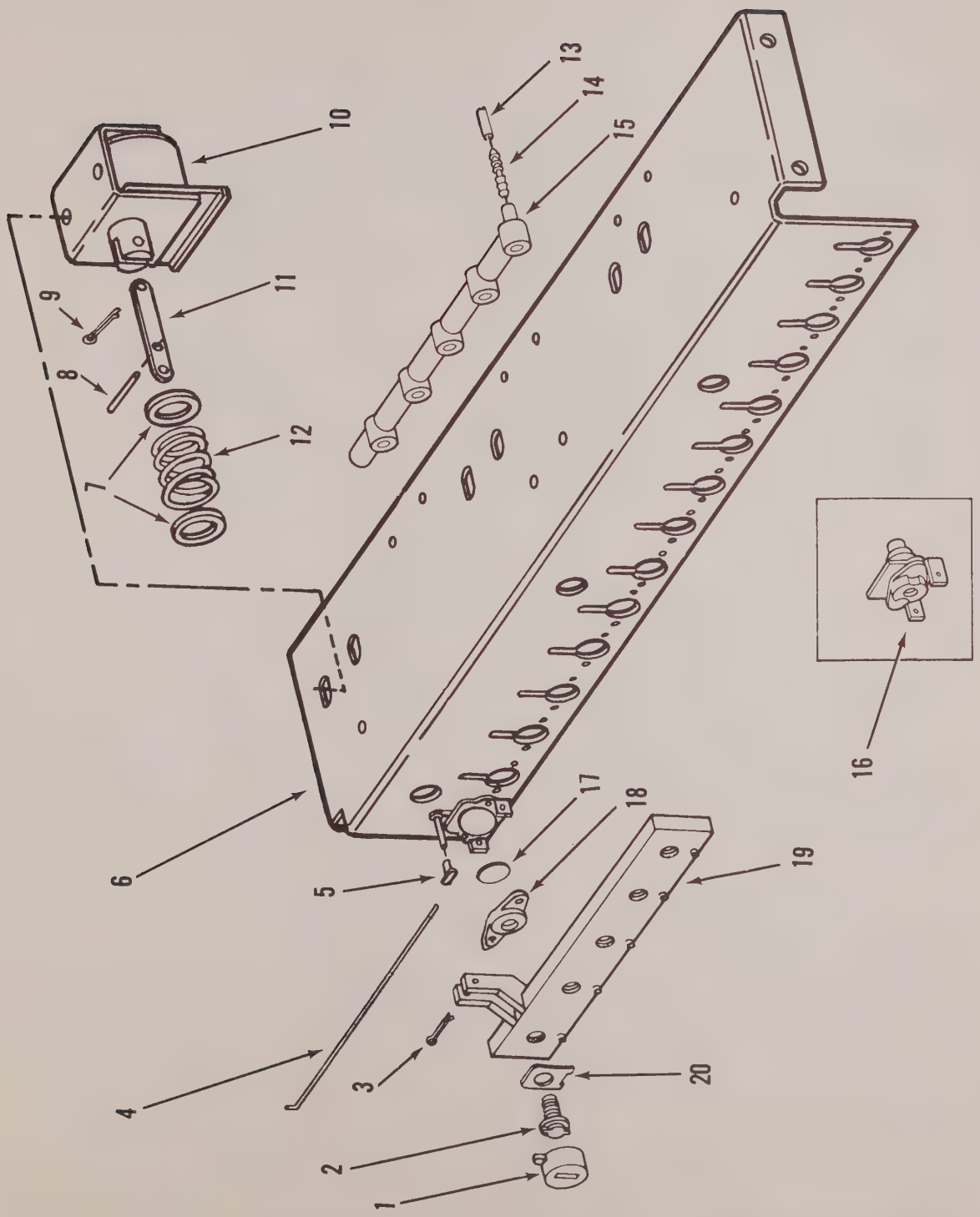


TABLE ASM, WRITING 869452
FIGURE 7-7

EXPLODED VIEW PARTS LIST
MANIFOLD ASSY 869478 - FIGURE 7-8

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL
1	467355-6	Knob, Ink Control	
2	467355-5	Screw, Operator	
3	236865-2	Cotter Pin	
4	269796	Shaft	
5	249360	Cap, Ink Outlet	
6	Not Used		
7	269805-1	Washer	
8	4-112468-33	Roll Pin	
9	2-128693-3	Grommet	
10	266888	Solenoid	L-301 thru 303
11	267414	Link, Connecting	
12	269549	Spring, Compression	
13	666582	Tube	
14	241843	Nipple	
15	367081	Manifold, Supply	
16	684169*	Valve Assembly	
17	267858	Diaphram	
18	467355-2	Retainer, Diaphram	
19	365991	Lever, Operator	
20	269683	Spring	

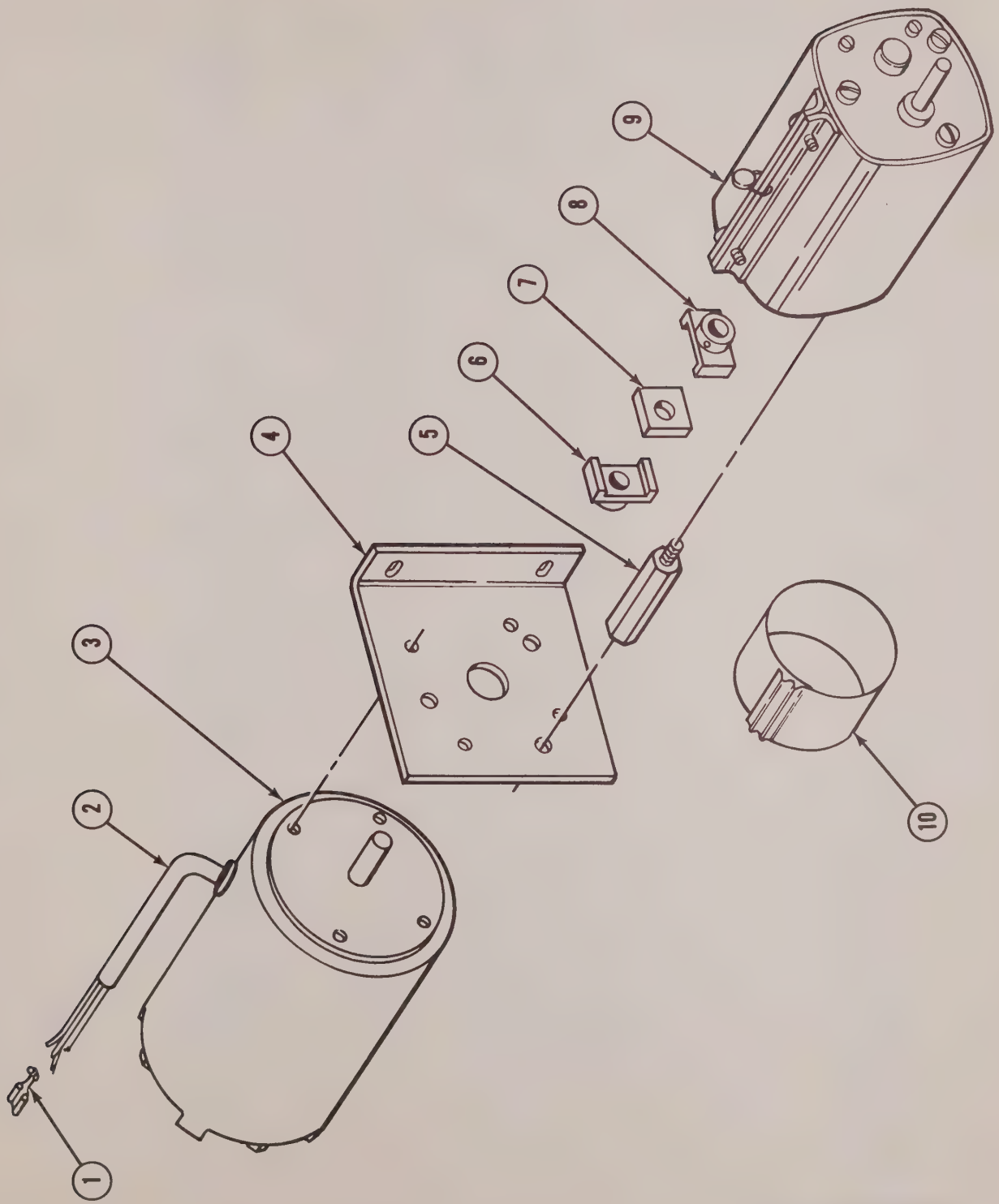
*Because of problems in replacement, I.S.D. does not recommend replacing this item. I.S.D. cannot guarantee leak-proof operation and recommends replacement of entire Manifold Assy No. 869478



MANIFOLD ASM 869478
FIGURE 7-8

EXPLODED VIEW PARTS LIST
DRIVE ASSEMBLY 869496 (-01)
DRIVE ASSEMBLY 869882 (-06)
FIGURE 7-9

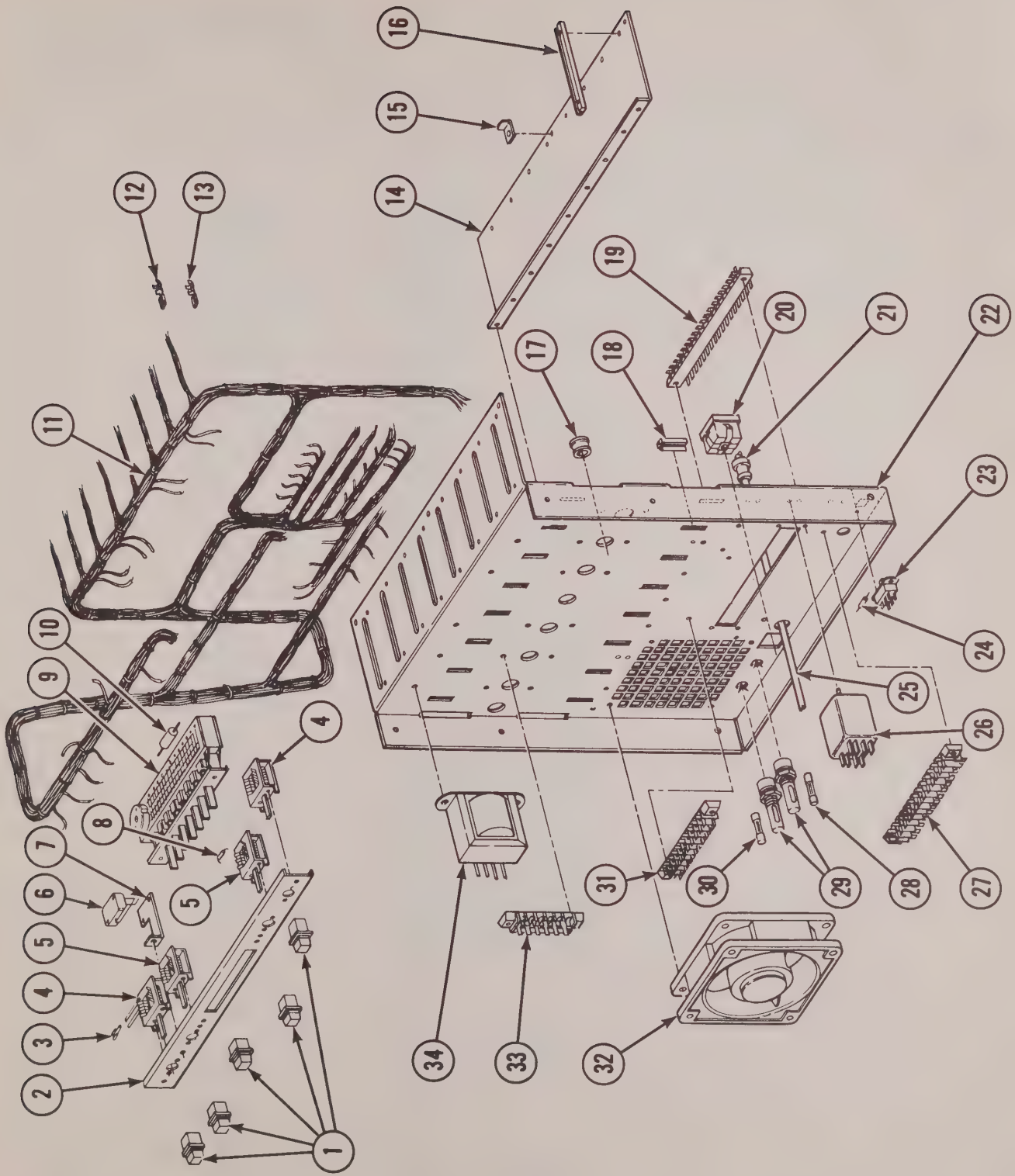
ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	265840-2	Terminal Lug	
2	128844-22	Tubing, Plastic	
3	317713-2	Motor, Hysteresis (-01)	B-302
3	267590	Motor, Hysteresis (-06)	B-302
4	369486	Plate, Motor Mtg	
5	127911	Post Mtg, Transmission	
6	127912	Coupling, Universal	
7	123695	Core, Coupling	
8	127913	Coupling, Universal	
9	12-2143-16	Transmission Asm (-01)	A-302
9	12-2157-16	Transmission Asm (-06)	A-302
10	242164	Guard, Splash	A-302



DRIVE ASM 869496
FIGURE 7-9

EXPLODED VIEW PARTS LIST
CHASSIS ASM, ELECTRICAL 869677 - FIGURE 7-10

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	246552-1	Button, Push	
2	369489	Bracket, Switch	
3	265840-1	Terminal Lug	
4	269257	Switch, Pushbutton	S-304 S-306
5	269259	Switch, Pushbutton	S-305 S-307
6	667373	Switch	S-303
7	269535	Bracket, Switch	
8	5-115557-182	Resistor	R-302
9	446357	Switch, Pushbutton	S-301 S-302
11	869680	Harness Asm	
12	265840-1	Terminal Lug	
13	265840-2	Terminal Lug	
14	369588	Bracket, Angle	
15	1-265849-4	Bracket, Angle	
16	269626	Retainer, PC Board	
17	130970-16	Bushing	
18	245808-1	Guide, PC Board	
19	267050-18	Terminal Board	TB-302 TB-303
20	244165	Connector	J-301
21	208572-11	Strain Relief	
22	869662	Chassis Subasm	
23	240224	Switch Slide	
24	5-115557-100	Resistor	R-303
25	126295-7	Cable, 3 Cord	P-302
26	267452	Relay, 3 PDT	K-301 K-302 K-303
27	265814-15	Terminal Board	TB-301
28	116198-14	Fuse (-01)	F-301
28	116198-29	Fuse (-06)	F-301
29	109669	Fuseholder	
30	116198-11	Fuse (-01)	F-302
30	116198-11	Fuse (-06)	F-302
31	265814-10	Terminal Board	TB-304
32	244887	Fan, Ventilation (-01)	B-301
32	263759-1	Fan, Ventilation (-06)	B-301
33	265814-6	Terminal Board	TB-305 thru TB-308
34	265542	Transformer, Power	T-301 thru T-308



CHASSIS ASM, ELECTRICAL 869677
FIGURE 7-10

EXPLODED VIEW PARTS LIST
NETWORK ASSEMBLY 869223
FIGURE 7-11

SYMBOL NO	PART NUMBER	DESCRIPTION
A-201	269062	Oscillator Module
C-201	231922-106	Capacitor
C-202	10-125904-203	Capacitor
C-203	243037-108	Capacitor
C-204*	10-241145-333	Capacitor
C-204	10-247116-333	Capacitor
C-205	269255-107	Capacitor
C-206	240352-101	Capacitor
C-207	243037-108	Capacitor
C-208*	10-241145-163	Capacitor
C-208	10-247116-153	Capacitor
C-209	241513-506	Capacitor
CR-201	244311	Semiconductor, Diode
CR-202	231869	Semiconductor, Diode
CR-203	244311	Semiconductor, Diode
CR-204	244311	Semiconductor, Diode
CR-205	231869	Semiconductor, Diode
CR-206	244311	Semiconductor, Diode
CR-207	231869	Semiconductor, Diode
CR-208	241133	Semiconductor, Diode
CR-209	10-244922-20	Semiconductor, Diode
CR-210	10-244922-20	Semiconductor, Diode
CR-211	244311	Semiconductor, Diode
CR-212	231869	Semiconductor, Diode
CR-213	231869	Semiconductor, Diode
CR-214	244311	Semiconductor, Diode
CR-215	265420-2	Rectifier, Bridge
CR-216	231887	Semiconductor, Diode
CR-217	269256-7	Semiconductor, Diode
CR-218	231887	Semiconductor, Diode
CR-219	231887	Semiconductor, Diode
CR-220	231887	Semiconductor, Diode
F-201	116198-7	Fuse
F-202	116198-7	Fuse
IC-201 *	230062	Semiconductor, IC
IC-201	230062-1	Semiconductor, IC
L-201	263453-1	Coil
L-202	263453-1	Coil
Q-201	230057-2	Transistor, 2N4922
Q-202	240236	Transistor, 2N1303
Q-203	240237	Transistor, 2N1302
Q-204	242323	Transistor
Q-205	240237	Transistor, 2N1302

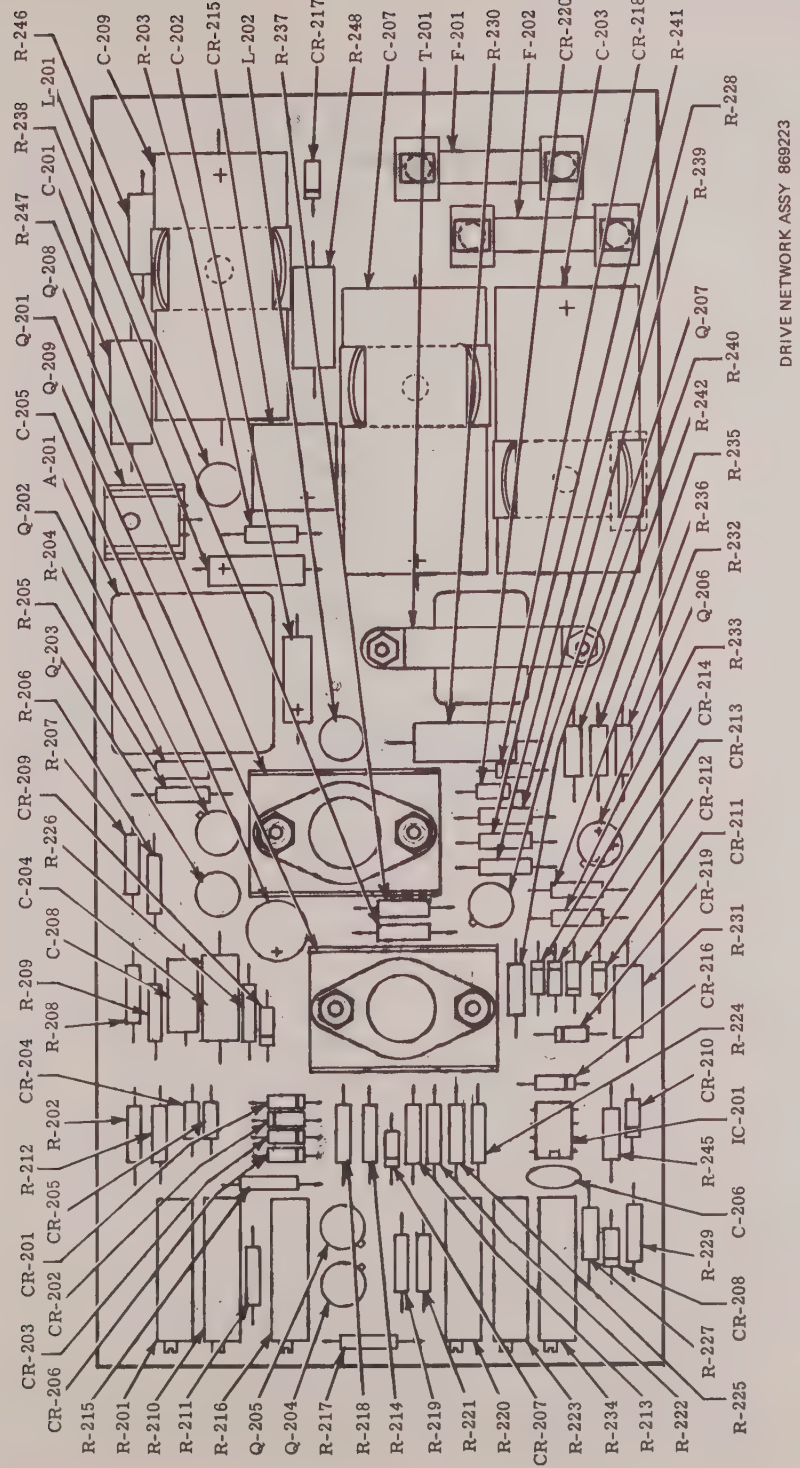
*Used on Assembly 869223, schematic 269587, Rev. D-1 (not shown)

EXPLODED VIEW PARTS LIST (continued)
NETWORK ASSEMBLY 869223
FIGURE 7-11

SYMBOL NO	PART NUMBER	DESCRIPTION
Q-206	242323	Transistor
Q-207	247149	Transistor
Q-208	267718-3	Transistor, 2N4900
Q-209	267716-3	Transistor, 2N4912
R-201	244771-502	Resistor, Variable
R-202	1-128182-3601	Resistor
R-203	5-115557-151	Resistor
R-204	5-115557-103	Resistor
R-205	5-115557-103	Resistor
R-206	1-128182-1502	Resistor
R-207	1-128182-1502	Resistor
R-208	1-128182-4701	Resistor
R-209	1-128182-2501	Resistor
R-210	244771-502	Resistor, Variable
R-211	1-128182-6801	Resistor
R-212	1-128182-91671	Resistor
R-213	1-128182-1103	Resistor
R-214	5-115557-822	Resistor
R-215	1-128182-1501	Resistor
R-216	244771-202	Resistor, Variable
R-217	1-128182-1501	Resistor
R-218	1-128182-5002	Resistor
R-219	1-128182-3901	Resistor
R-220	244771-202	Resistor, Variable
R-221	1-128182-2501	Resistor
R-222	1-128182-5601	Resistor
R-223	244771-502	Resistor, Variable
R-224	1-128182-5601	Resistor
R-225	1-128182-1103	Resistor
R-226	1-128182-2702	Resistor
R-227	5-115557-273	Resistor
R-228	1-128182-5003	Resistor
R-229	1-128182-5002	Resistor
R-230	5-115558-181	Resistor
R-231	5-115558-271	Resistor
R-232	5-115557-183	Resistor
R-233	5-115557-183	Resistor
R-234	244771-103	Resistor, Variable
R-235	5-115557-471	Resistor
R-236	5-115557-471	Resistor
R-237	5-115557-471	Resistor
R-238	5-115557-471	Resistor
R-239	5-115557-332	Resistor
R-240	5-115557-332	Resistor

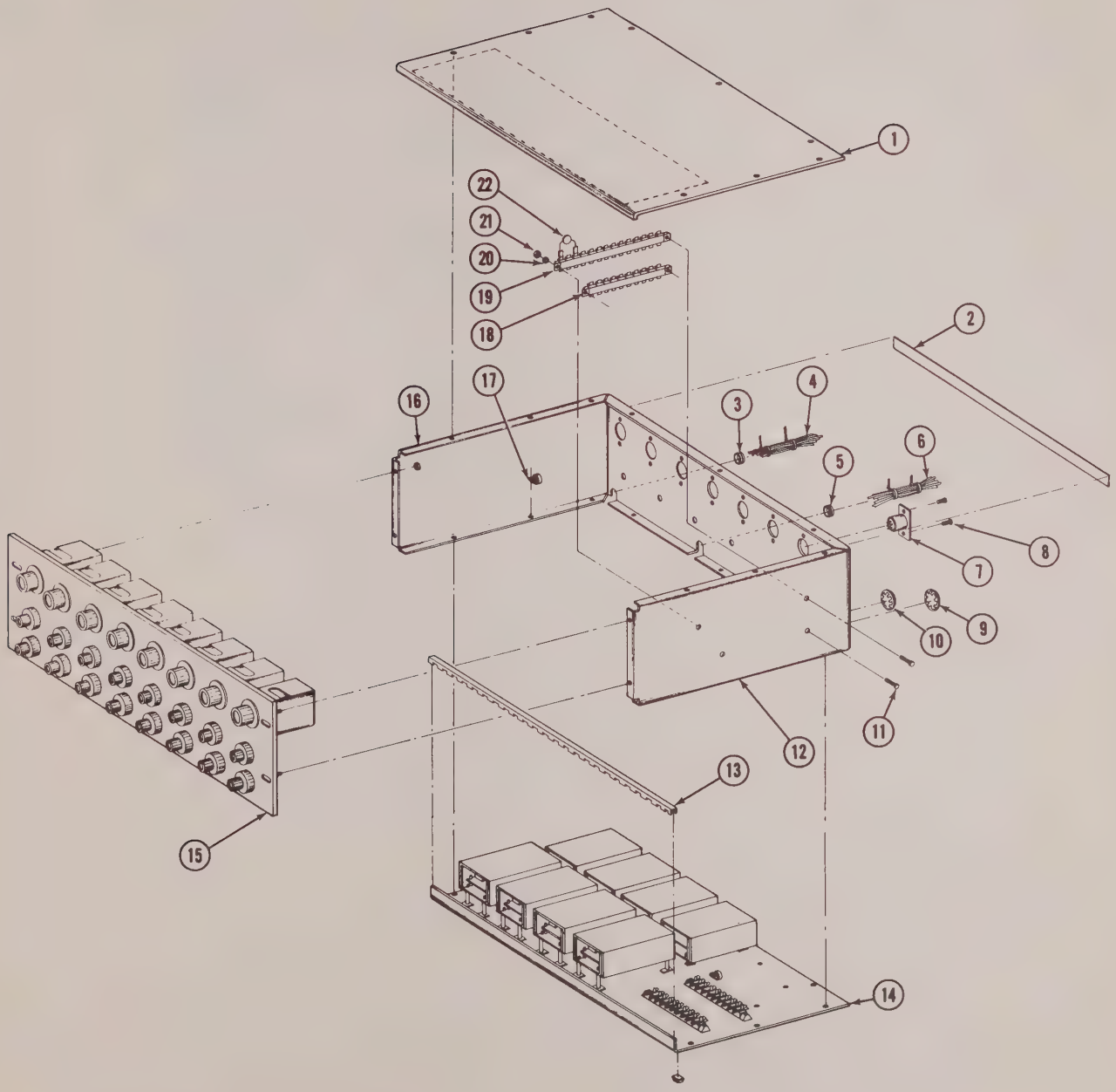
EXPLODED VIEW PARTS LIST (continued)
NETWORK ASSEMBLY 869223
FIGURE 7-11

SYMBOL NO	PART NUMBER	DESCRIPTION
R-241	5-115557-103	Resistor
R-242	5-115557-122	Resistor
R-243	Not Used	
R-244	Not Used	
R-245	5-115557-102	Resistor
R-246	5-115558-220	Resistor
R-247	5-115559-152	Resistor
R-248	5-115559-152	Resistor
T-201	263516	Transformer


R-246
C-209
R-203
C-202
CR-215
L-202
R-237
CR-217
R-248
C-207
T-201
F-201
R-230
F-202
CR-220
C-203
CR-218
R-241
R-228
R-239
Q-207
R-240
R-242
R-235
R-236
R-232
Q-206
R-233
CR-214
CR-213
CR-211
CR-212
CR-219
CR-216
R-231
R-224
CR-210
IC-201
R-245
R-229
C-206
CR-208
R-227
R-225
R-222
R-213
R-234
R-223
CR-207
R-220
R-221
R-219
R-214
R-218
R-217
Q-204
Q-205
R-216
R-211
R-210
R-201
R-215
CR-206
CR-202
CR-205
R-202
R-208
C-208
R-226
R-207
Q-203
R-206
R-205
R-204
A-201
Q-209
Q-208
C-201
R-247
R-238
L-201
Q-201
C-205
Q-202
CR-209
C-204
R-209
CR-204
R-212
CR-201
CR-203
DRIVE NETWORK ASSY 869223

EXPLODED VIEW PARTS LIST
PREAMPLIFIER ASSEMBLY 883148
FIGURE 7-12 (SHEET 1 OF 3)

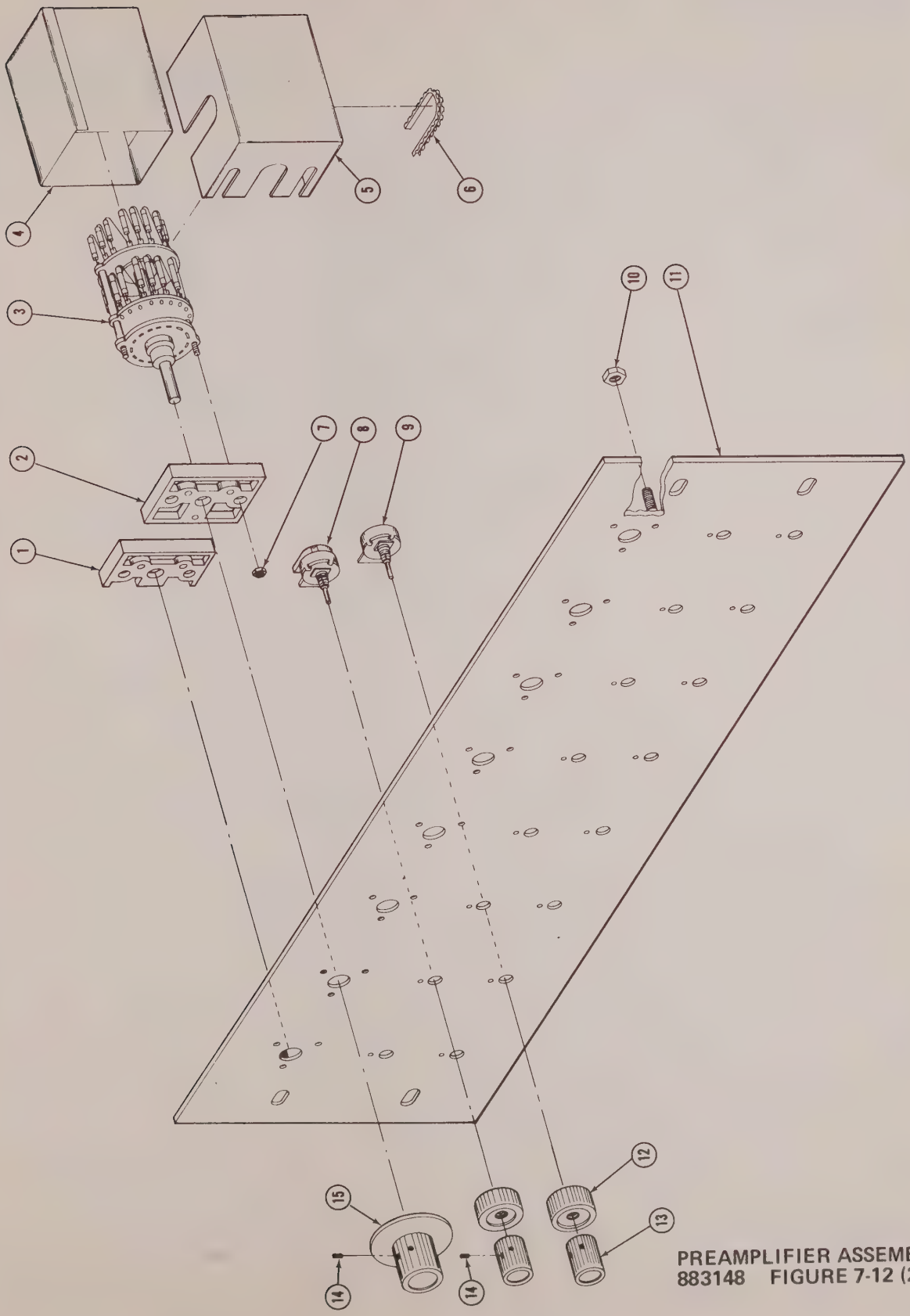
ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	782965	Cover Asm, Top	
2	782043	Label	
3	123108-72	Grommet	
4	882973	Harness Asm	
5	123108-82	Grommet	
6	882968	Harness Asm	
7	234323	Connector, Recept, Male	P-401 thru 408
8	13-262715-4004	Screw, Self Tap, Flat Hd	
9	113294-44	Button, Plug	
10	113294-61	Button, Plug	
11	31-119918-4008	Screw, Mach, Pan Hd	
12	482970	Chassis	
13	2-128693-1	Grommet	
14	382964	Bottom Plate	
15	882969	Panel Asm	
16	31-129647-02	Nut	
17	124804-4	Clamp, Cable	
18	265814-10	Terminal Bd, Q.C.	TB-407
19	265814-14	Terminal Bd, Q.C.	TB-408
20	1-216741-411	Lockwasher, Spring	
21	31-119998-40	Nut, Hex	
22	240352-103	Capacitor	C-401 thru C-416



PREAMPLIFIER ASSEMBLY
883148 FIGURE 7-12 (1 OF 3)

EXPLODED VIEW PARTS LIST
PREAMPLIFIER ASSEMBLY 883148
FIGURE 7-12 (SHEET 2 OF 3)

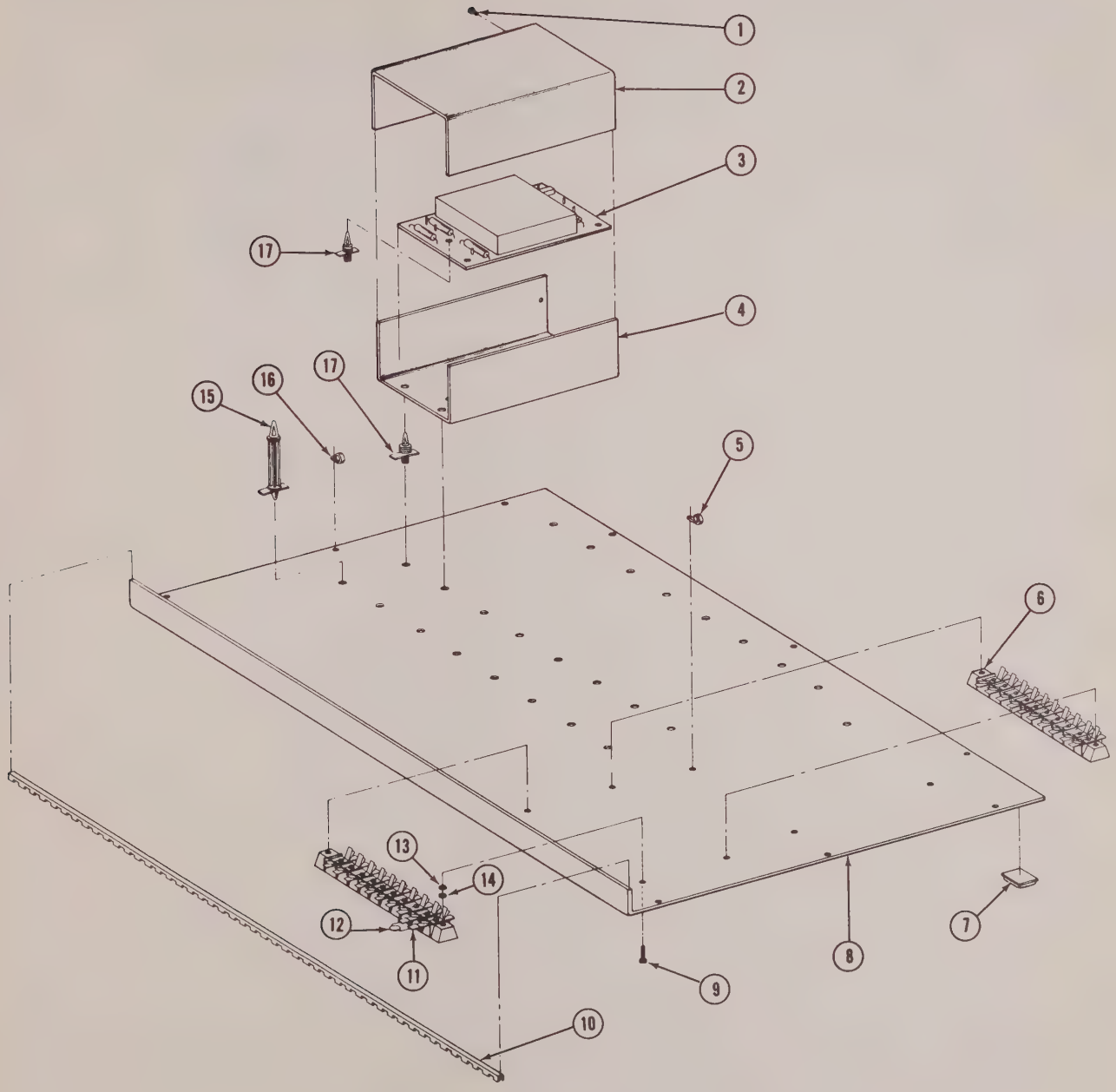
ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	682962	Plate, Modified	
2	281996	Plate, Mtg.	
3	882972	Switch (See Figure 7-15)	
4	281904	Insulator	
5	281902	Cover	
6	2-128693-1	Grommet	
7	31-119998-40	Nut, Hex	
8	246393-202	Resistor, Vari w/switch	R/S-410 thru 418
9	246394-502	Resistor, Vari	R-419 thru 426
10	31-129647-02	Nut, Hex	
11	882969	Panel Asm	
12	231182	Nut, Self Locking	
13	231183	Knob	
14	13-119923-6202	Screw, Set	
15	665563	Knob Asm	



PREAMPLIFIER ASSEMBLY
883148 FIGURE 7-12 (2 OF 3)

EXPLODED VIEW PARTS LIST
PREAMPLIFIER ASSEMBLY 883148
FIGURE 7-12 (SHEET 3 OF 3)

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	13-262716-4004	Screw, Self Tap	
2	282963	Cover, Preamp	
3	766409	Preamp Assy (See Figure 7-14)	
4	282961	Holder, Preamp	
5	124804-3	Clamp, Cable	
6	265814-10	Terminal Bd, Q.C.	TB-405, 406
7	230076	Bumper, Rubber	
8	382964	Plate, Bottom	
9	31-119918-4008	Screw, Mach, Pan Hd	
10	2-128693-1	Grommet	
11	265840-1	Terminal Lug	
12	240352-103	Capacitor (Same as Fig. 7-12, Sheet 1 of 1, Item 22)	
13	31-119998-40	Nut, Hex	
14	1-216741-411	Lockwasher, Spring	
15	281515-7	Support Spacer	
16	124804-2	Clamp, Cable	
17	281515-2	Support Spacer	



PREAMPLIFIER ASSEMBLY
883148 FIGURE 7-12 (3 OF 3)

FIGURE 7-13
EXPLODED VIEW PARTS LIST
CHASSIS SUBASSEMBLY–

ITEM NO	PART NUMBER	DESCRIPTION	SYMBOL NO
1	Part of item 5	Lock Ring	
2	265840-1	Terminal	
3	782987	Harness	
4	782966	Chassis Assy	
5	265873-2	Jack, Banana	
6	267050-10	Terminal Board	TB-401 thru 404

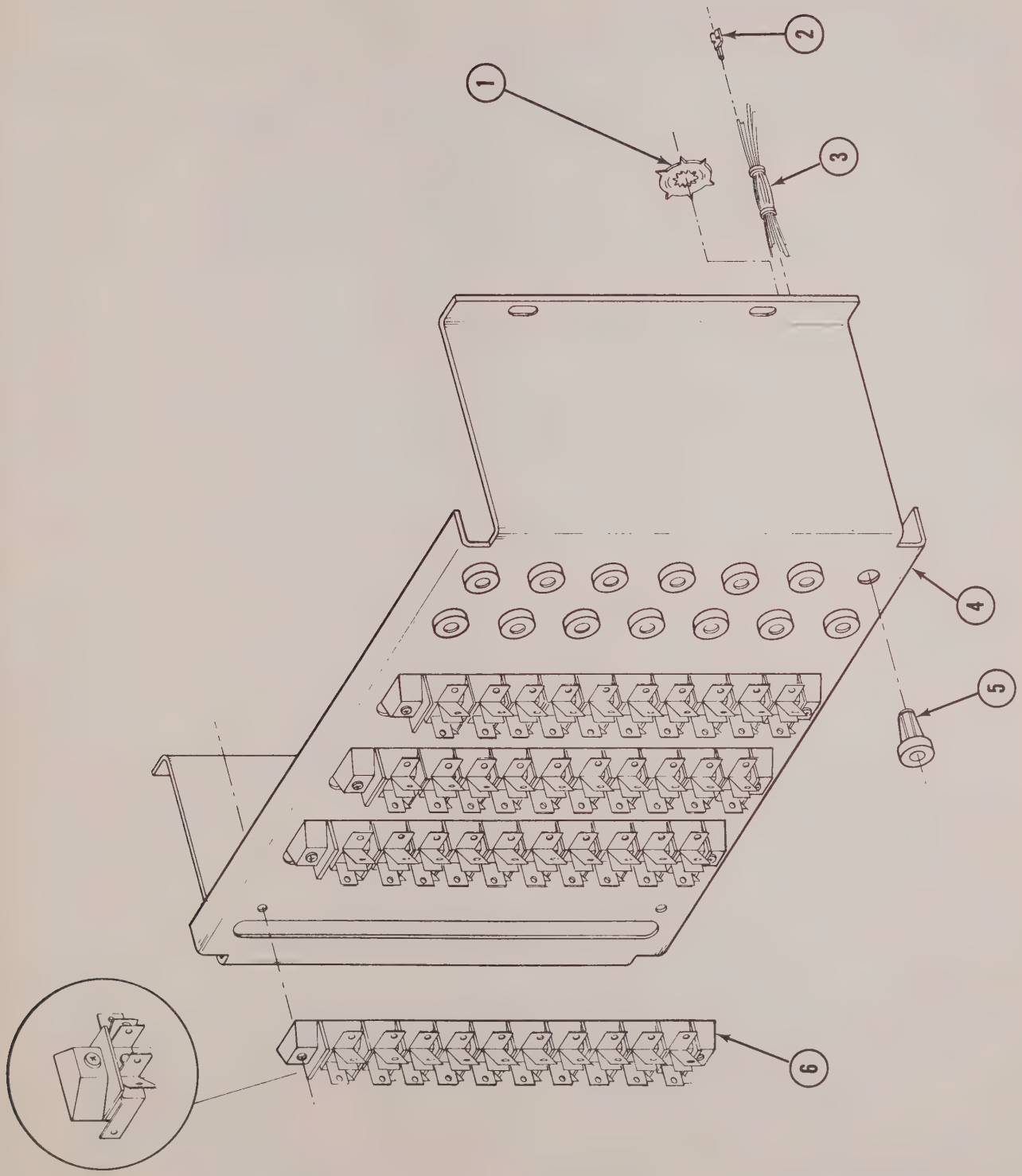
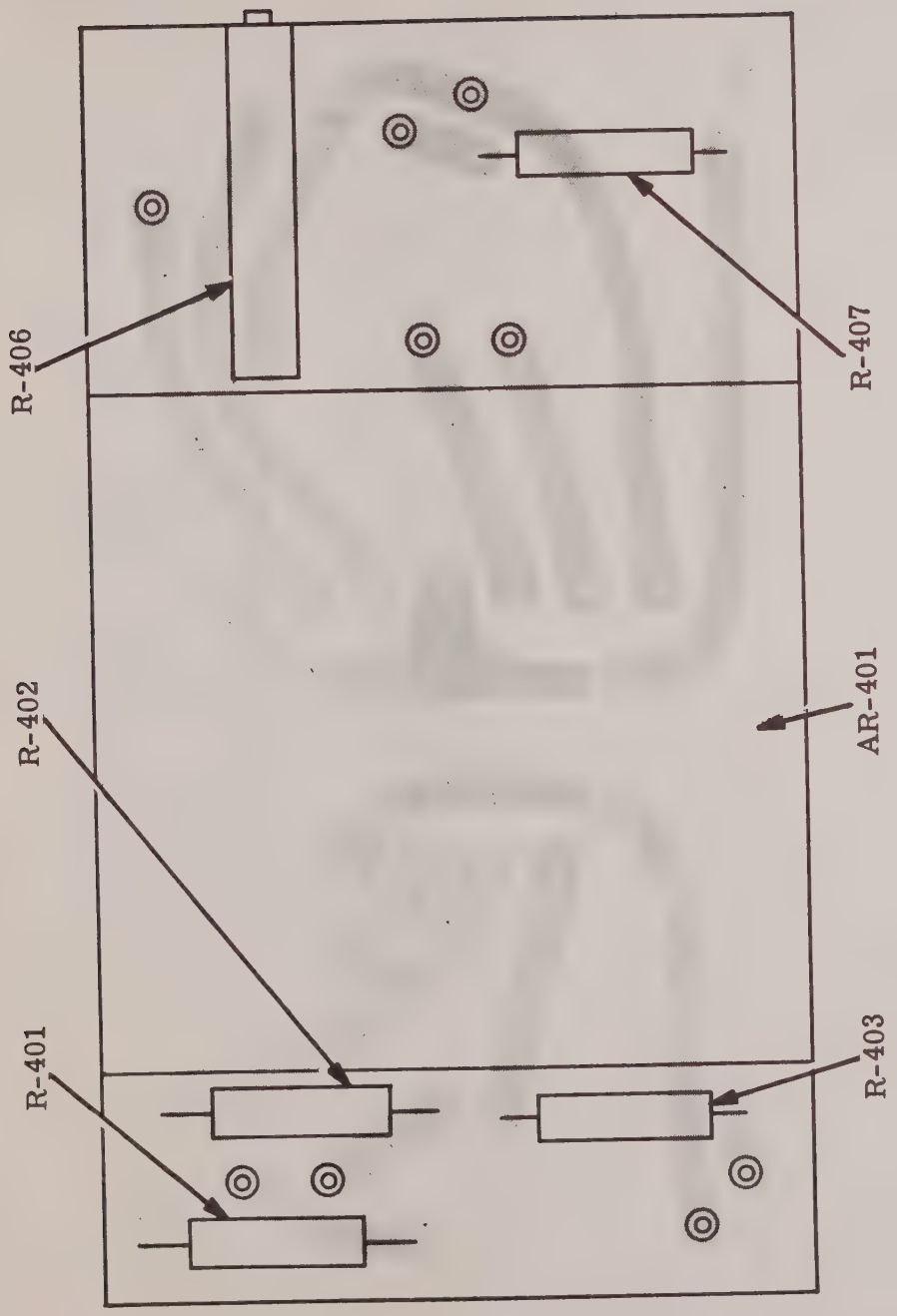


FIGURE 7-13
CHASSIS SUBASSEMBLY

EXPLODED VIEW PARTS LIST
PREAMPLIFIER ASSEMBLY 766409
FIGURE 7-14

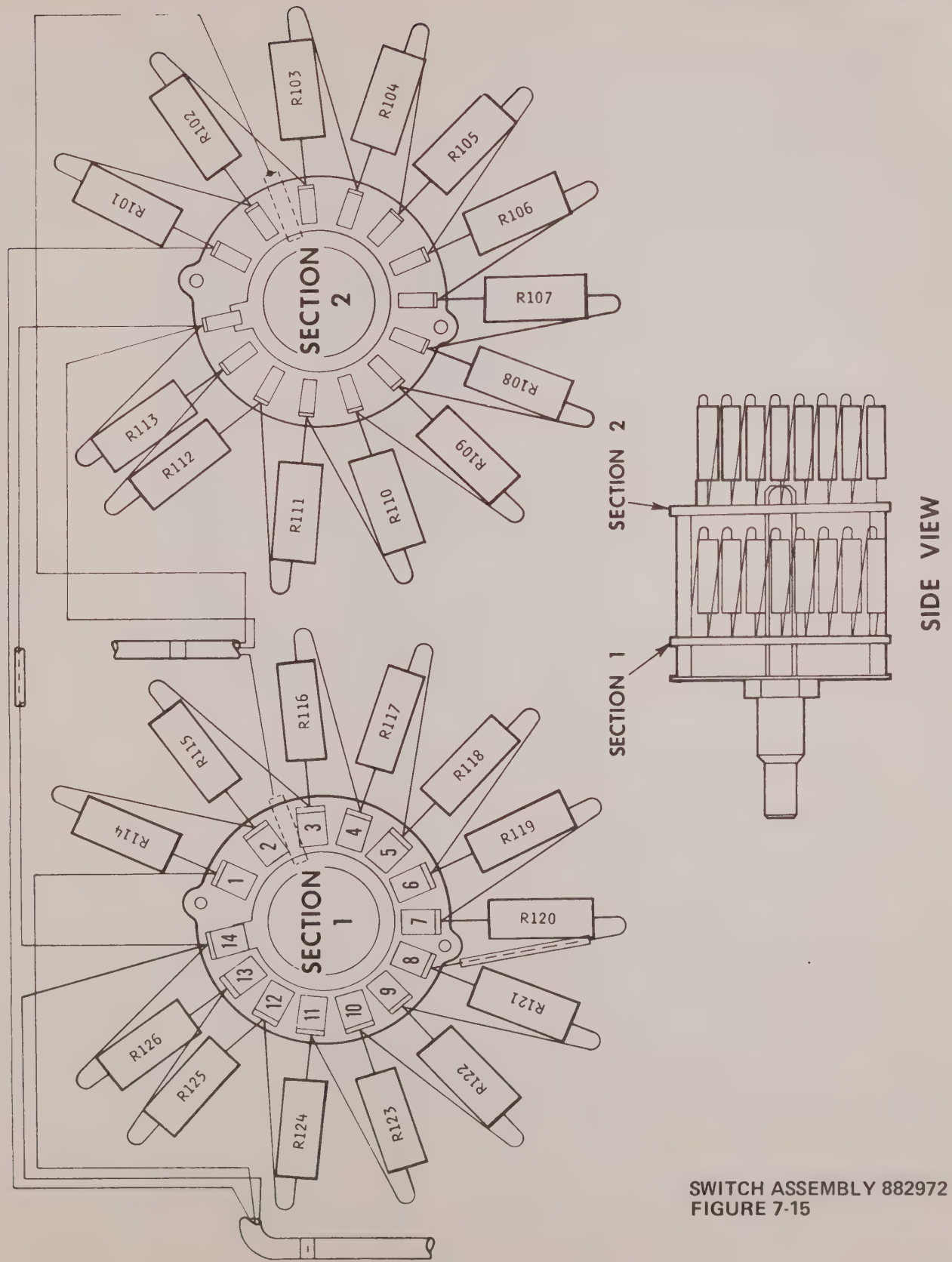
SYMBOL NO	PART NUMBER	DESCRIPTION
AR-401	266002	Transducer Amplifier
R-401	1-117802-5003	Resistor
R-402	1-117802-5003	Resistor
R-403	1-128182-1001	Resistor
R-406	266337-503	Resistor, Variable
R-407	5-115557-331	Resistor



PREAMPLIFIER ASSEMBLY 766409
FIGURE 7-14

EXPLODED VIEW PARTS LIST
SWITCH ASSEMBLY 882972
FIGURE 7-15

SYMBOL NO	PART NUMBER	DESCRIPTION
R-101	50-128182-2504	Resistor
R-102	50-128182-1504	Resistor
R-103	50-128182-5003	Resistor
R-104	50-128182-2503	Resistor
R-105	50-128182-1503	Resistor
R-106	50-128182-5002	Resistor
R-107	50-128182-2502	Resistor
R-108	50-128182-1502	Resistor
R-109	50-128182-5001	Resistor
R-110	50-128182-2501	Resistor
R-111	50-128182-1501	Resistor
R-112	50-128182-5000	Resistor
R-113	50-128182-5000	Resistor
R-114	50-128182-2504	Resistor
R-115	50-128182-1504	Resistor
R-116	50-128182-5003	Resistor
R-117	50-128182-2503	Resistor
R-118	50-128182-1503	Resistor
R-119	50-128182-5002	Resistor
R-120	50-128182-2502	Resistor
R-121	50-128182-1502	Resistor
R-122	50-128182-5001	Resistor
R-123	50-128182-2501	Resistor
R-124	50-128182-1501	Resistor
R-125	50-128182-5000	Resistor
R-126	50-128182-5000	Resistor
S-101	281955	Switch



SWITCH ASSEMBLY 882972
FIGURE 7-15

EXPLODED VIEW PARTS LIST
CHART TAKE-UP ASSEMBLY
MODEL 11-6402-06
FIGURE 7-16

ITEM NO	PART NUMBER	DESCRIPTION
1	680147	Pulley Asm
2	747033	Gear Case Motor
3	246307	Block, Threaded
4	243192	Plate, I.D. Model No.
5	1-249616-6203	Screw, Pan Head
6	267253	Spring, Compression
7	280048	Shaft, Shouldered
8	769981-2	Arm R.H.
9	669598	Shaft Asm
10	4-112468-14	Pin, Roll
11	243740	Collar, Shaft
12	769979-2	Arm Asm, L.H.
13	269986	Shaft, Shouldered
14	280049	Pulley, Timing
15	269945	Belt, Timing
16	669985-2	Plate, Cover, Left
17	280021	Pulley, Idler
18	246307	Block, Threaded
19	1-249640-8206	Screw

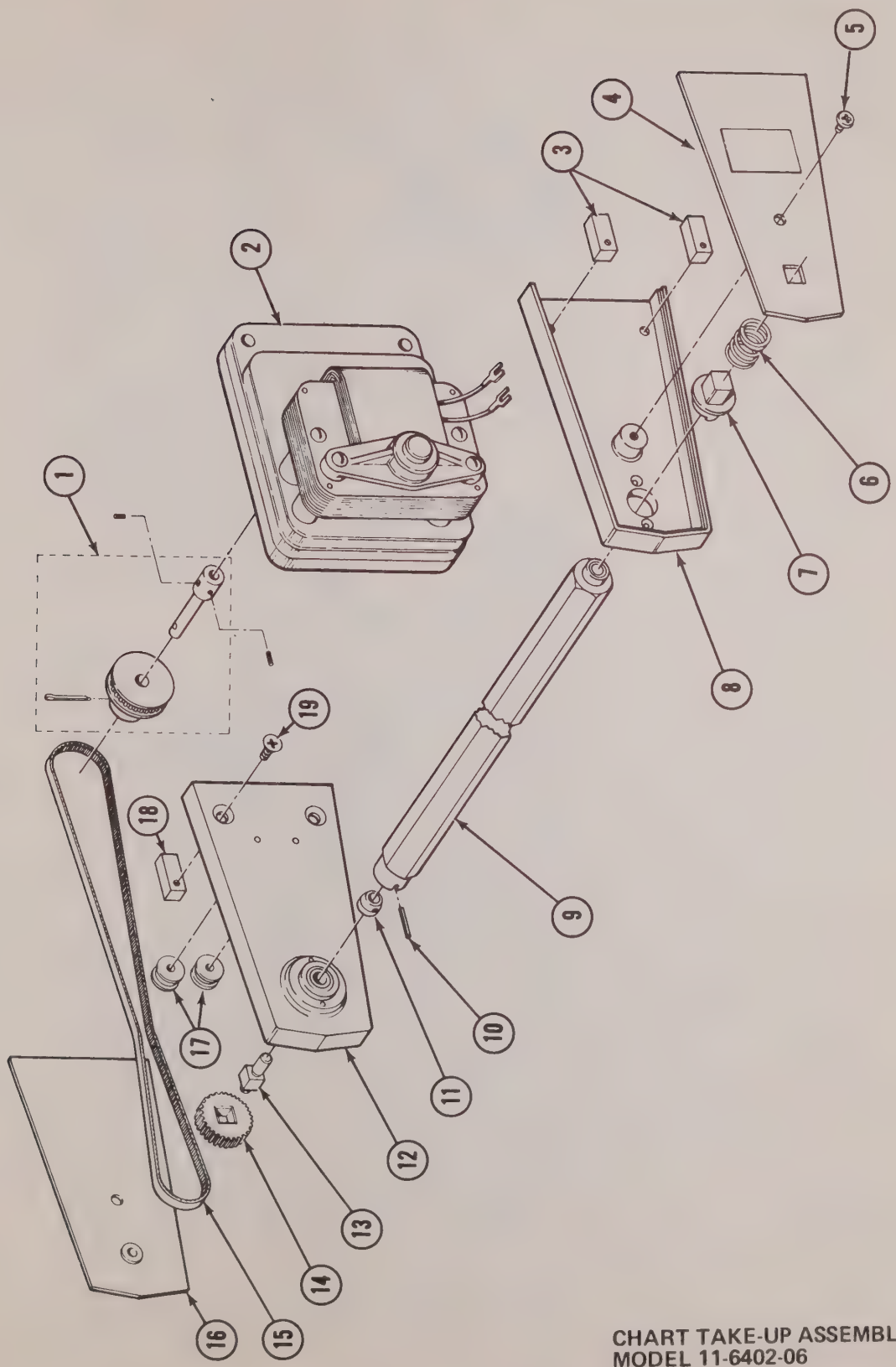
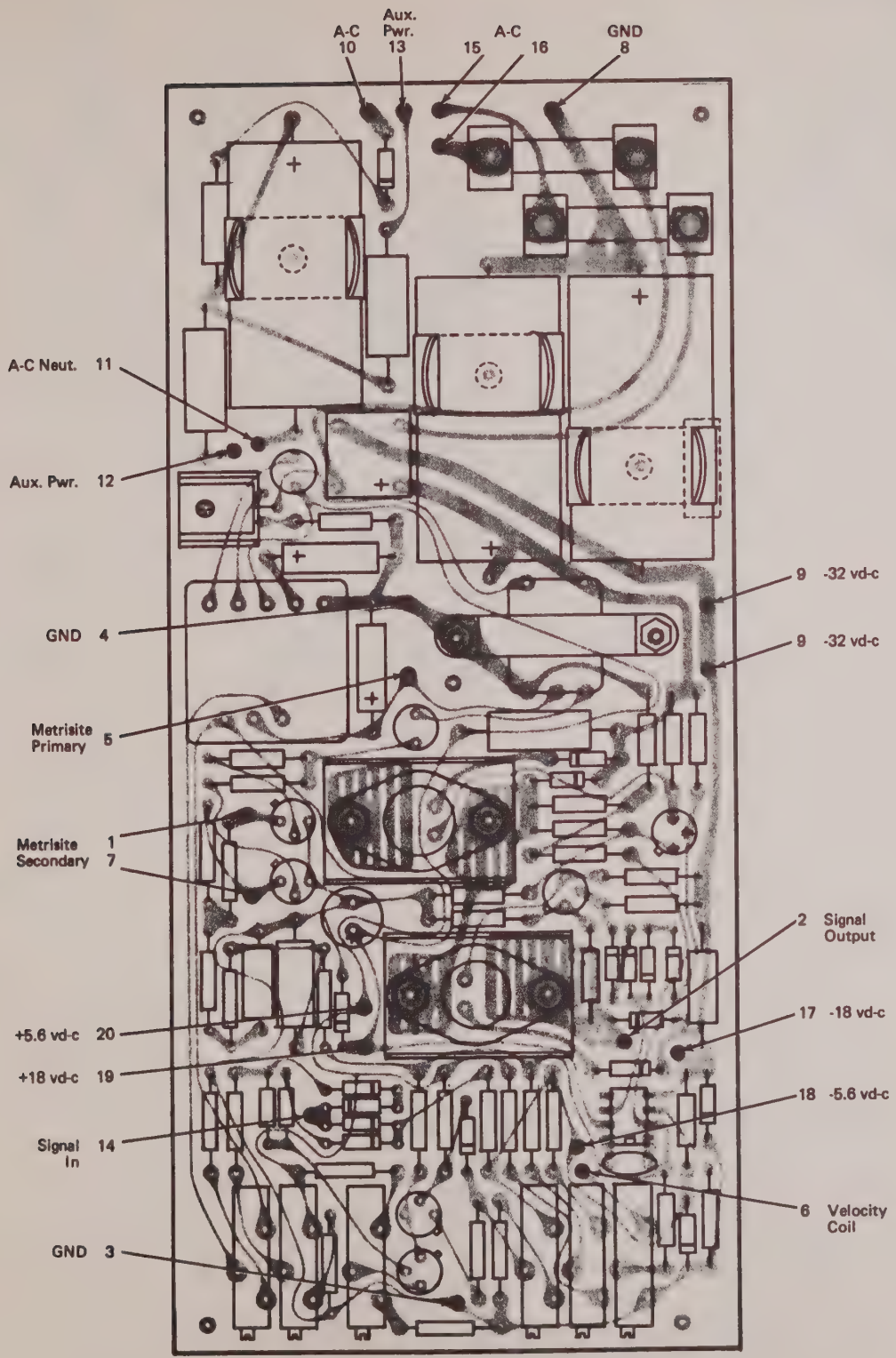
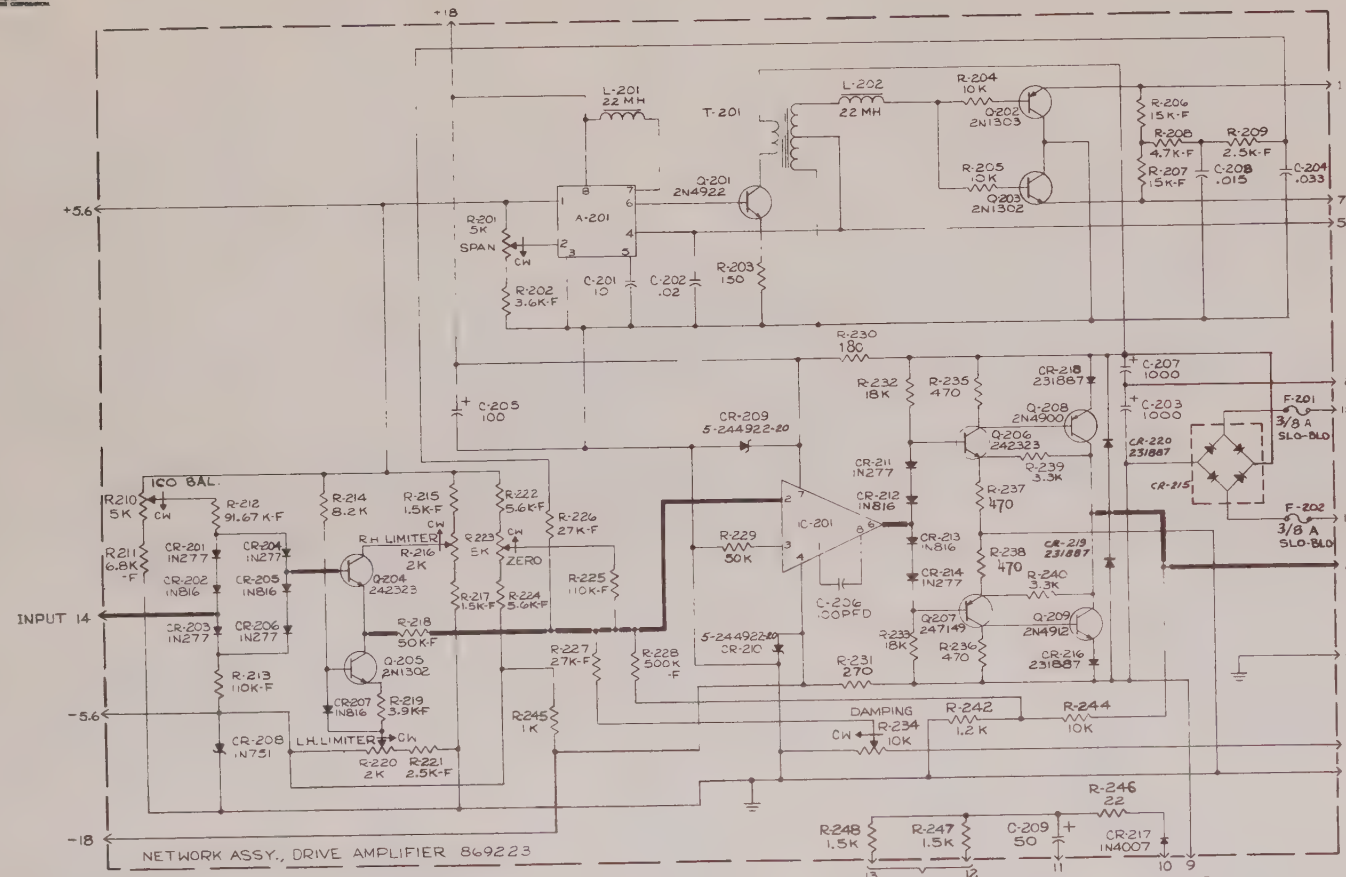


CHART TAKE-UP ASSEMBLY
MODEL 11-6402-06
FIGURE 7-16



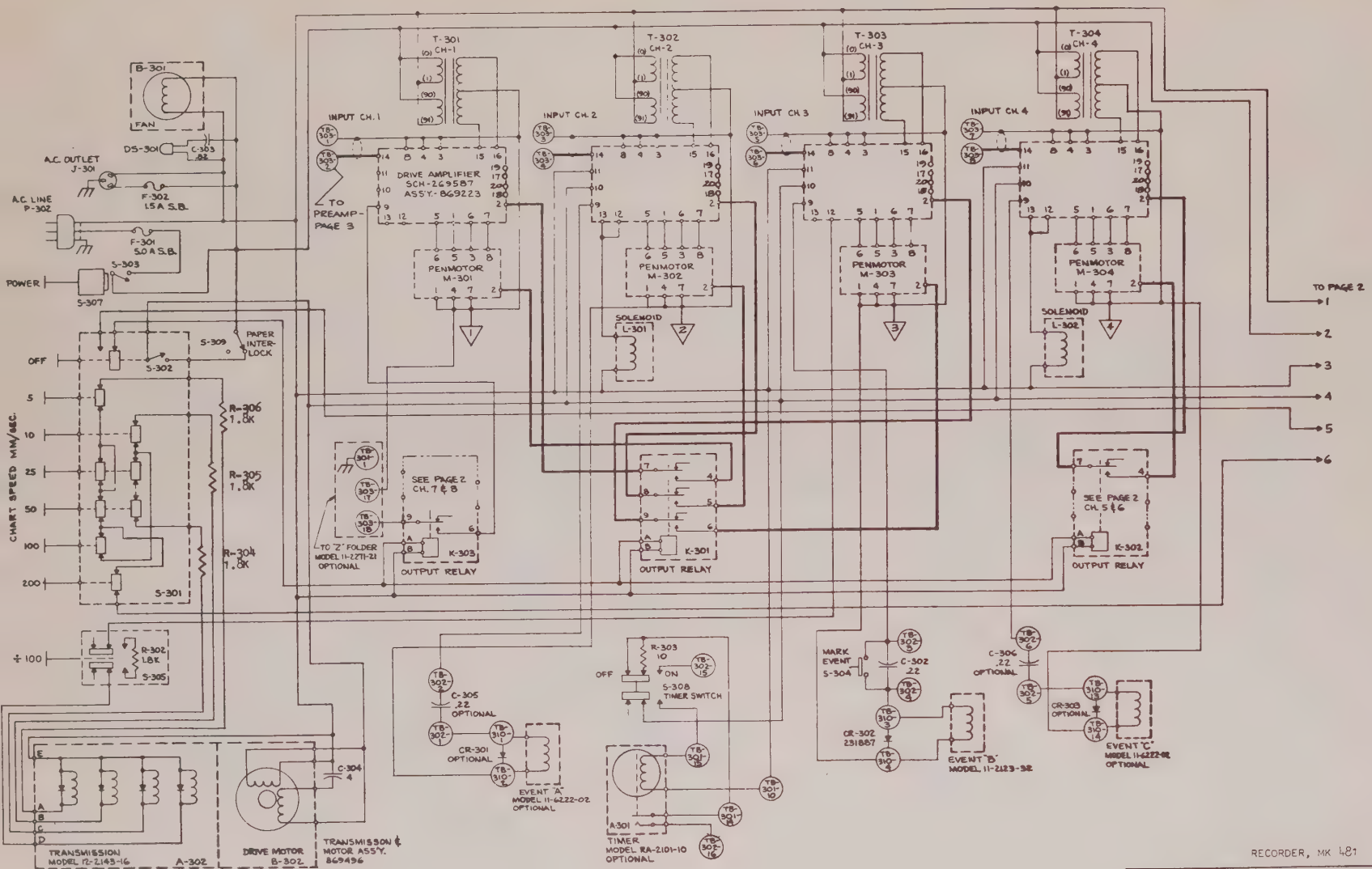
The numbers and voltages on this page refer to the numbers and voltages on schematic 269587.



REVISIONS		
SYM	DESCRIPTION	DATE
B-1	REDRAWN PER E. VAUGHN R-237 & R-238 WAS: 1K DCN 12409 E. PREDOVIC	11-6-69
C-1	REVISED PER DCN 12421	11-10-69
C-2	REVISED PER DCN 12432	11-14-69
D-1	REV. PER DCN 12444	11-20-69
E-1	ADDED F-201 & F-202 PER DCN 15572 HOTCHKISS	1-5-
F-1	F-201, F-202 WAS: 3/4 A DCN 15943 EP	6-8-71
G-1	ADDED CR-219 & CR-220 PER DCN 14890	JLK 8-22-72
H-1	CR-209, CR-210 WERE 10-244922-8 DCN 16050	JLK 10-5-72

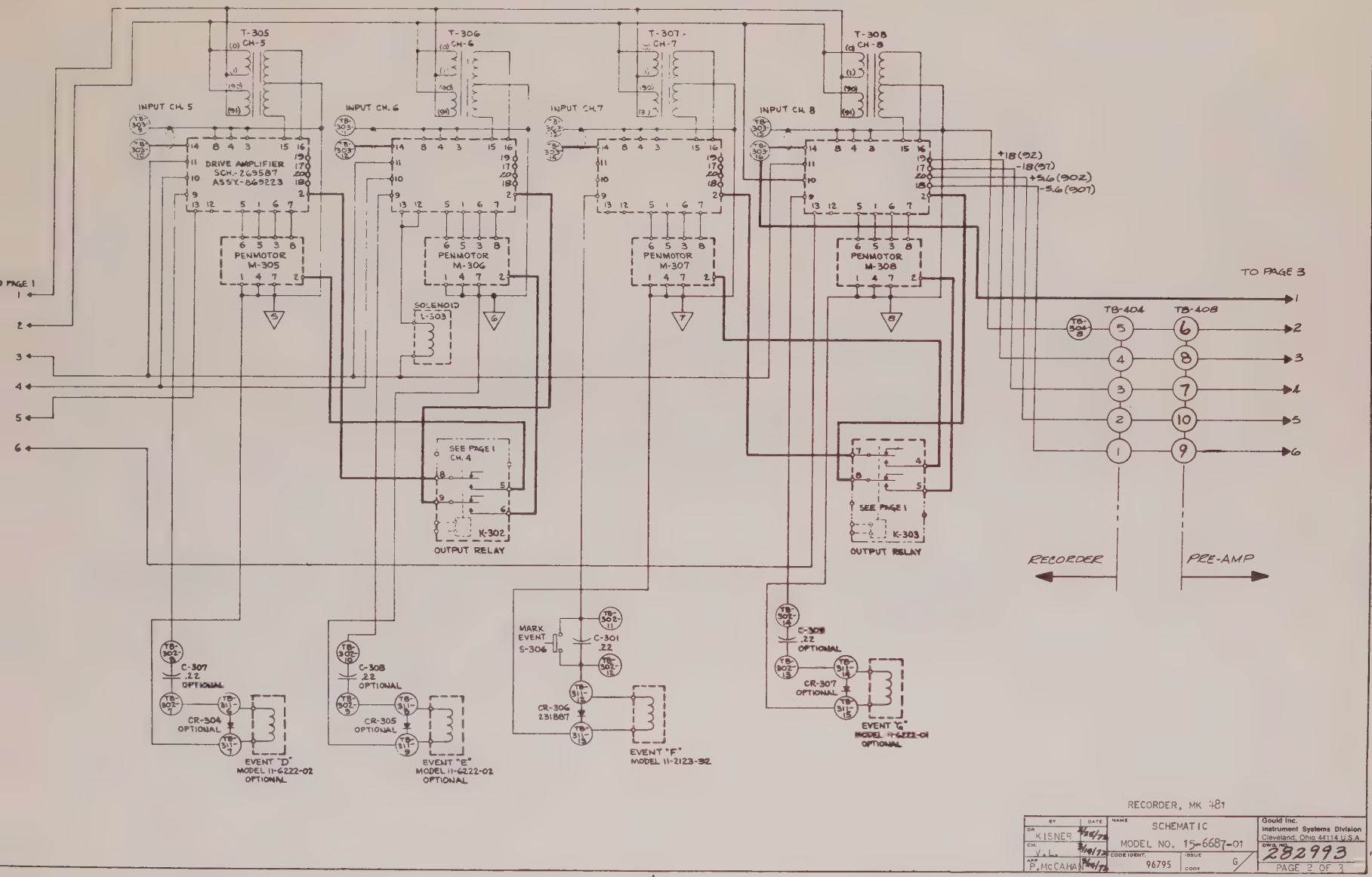
Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.

BY	DATE	NAME	SCHEMATIC	
D. SALVATORE/			ASSEMBLY NO. 869223	DWG. NO. 269587
CH. V.L.		CODE IDENT	ISSUE CODE G	
APP. L.J.W.				



RECORDER, MK 481

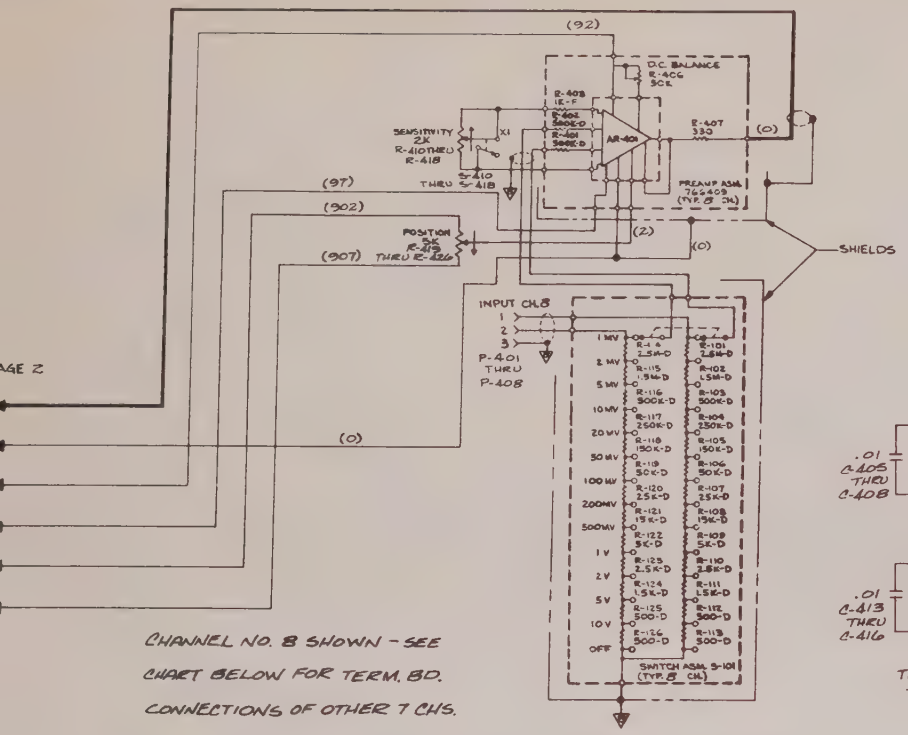
BY	DATE	NAME		
DR KISNER	7/6/72	SCHEMATIC		Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.
CH		MODEL NO. T5-6687-01		
APP McCAHAN	7/10/72	CODE IDENT 96795	ISSUE CODE G	DWG NO. 282993
				PAGE 1 OF 3



RECORDER, MK 481

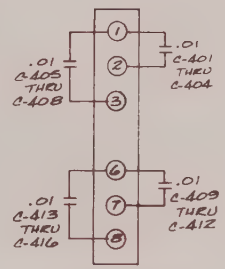
BY	DATE	NAME	SCHEMATIC	Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.
DR KISNER	3/28/72	MODEL NO. 15-6687-01		
CH. V.L.	3/29/72	CODE IDENT. 96795	ISSUE CODE G	DWG. NO. 282993
APP P. McCAHAN	3/29/72			PAGE 2 OF 3

282993

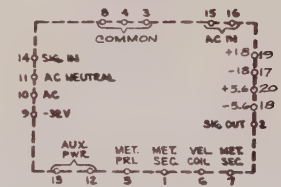


AGE 2

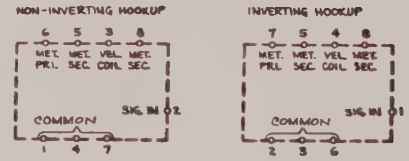
CHANNEL NO. 8 SHOWN - SEE CHART BELOW FOR TERM. BD. CONNECTIONS OF OTHER 7 CHS.



DRIVE AMPLIFIER CONNECTIONS



PENMOTOR ASSY. NO. 867060



TERM. BD.	304	401	402	403	404	405	406	407	408	303
CONTACT 1	1 0	2 907	4 907	6 907	8 907	1 0	3 0	5 0	7 0	1
2	2 0	2 902	4 902	6 902	8 902	1 97	3 97	5 97	7 97	1 0
3	3 0	2 97	4 97	6 97	8 97	1 92	3 92	5 92	7 92	2
4	4 0	2 92	4 92	6 92	8 92	1 907	3 907	5 907	7 907	2 0
5	5 0	2 0	4 0	6 0	8 0	1 902	3 902	5 902	7 902	3
6	6 0	1 907	3 907	5 907	7 907	2 0	4 0	6 0	8 0	3 0
7	7 0	1 902	3 902	5 902	7 902	2 97	4 97	6 97	8 97	4
8	8 0	1 97	3 97	5 97	7 97	2 92	4 92	6 92	8 92	4 0
9		1 92	3 92	5 92	7 92	2 907	4 907	6 907	8 907	5
CONTACT 10		1 0	3 0	5 0	7 0	2 902	4 902	6 902	8 902	5 0

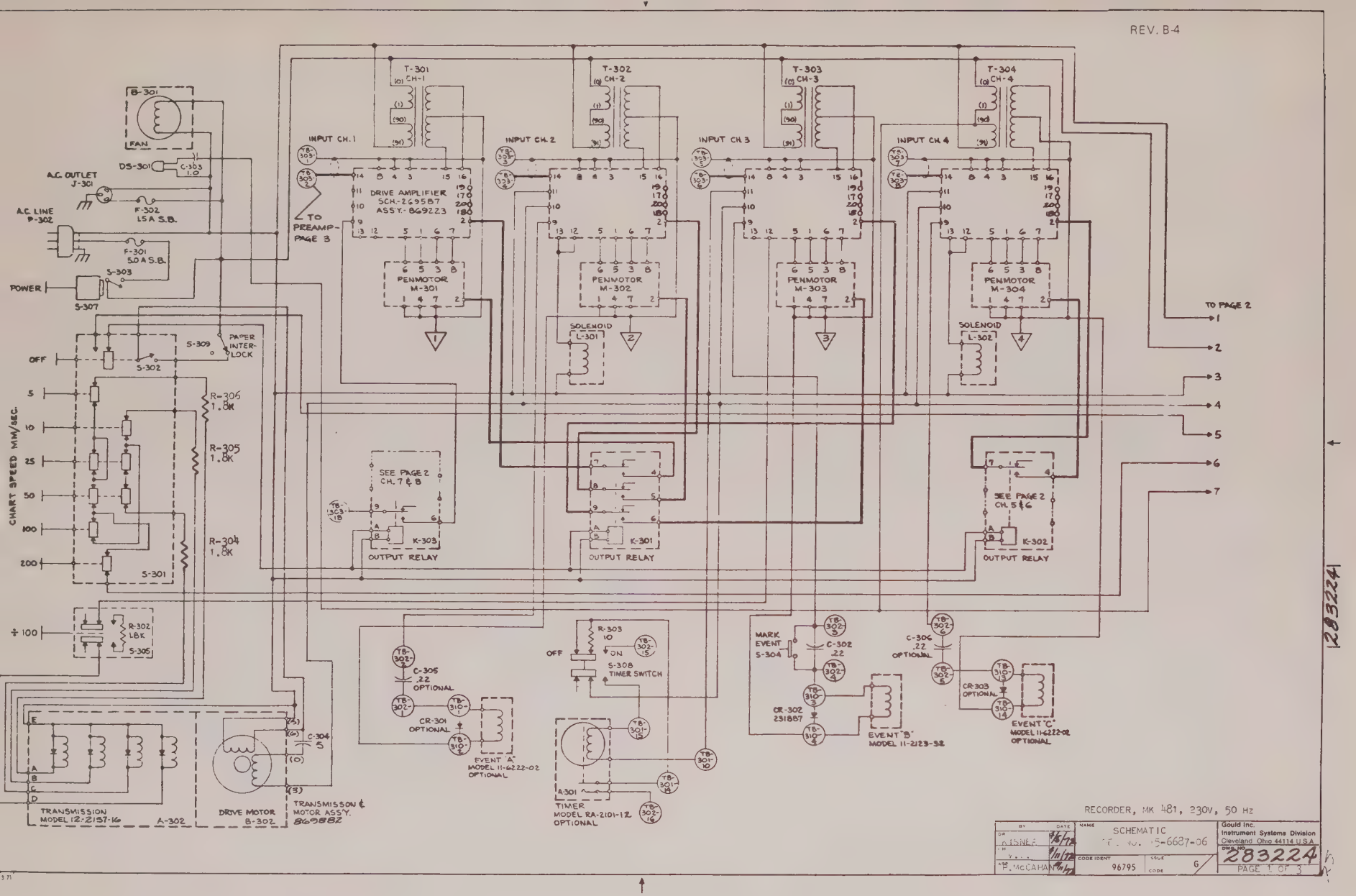
WIRE COLOR
CH. NO.
TYP. 8 CHS.

NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTOR VALUES IN OHMS.
   ALL RESISTORS 5% TOLERANCE.
   ALL CAPACITOR VALUES IN MICROFARADS.
2. HEAVY LINES REPRESENT SIGNAL FLOW.
3. SCHEMATIC ILLUSTRATES NON-INVERTING HOOKUP TO PENMOTOR.
4. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).

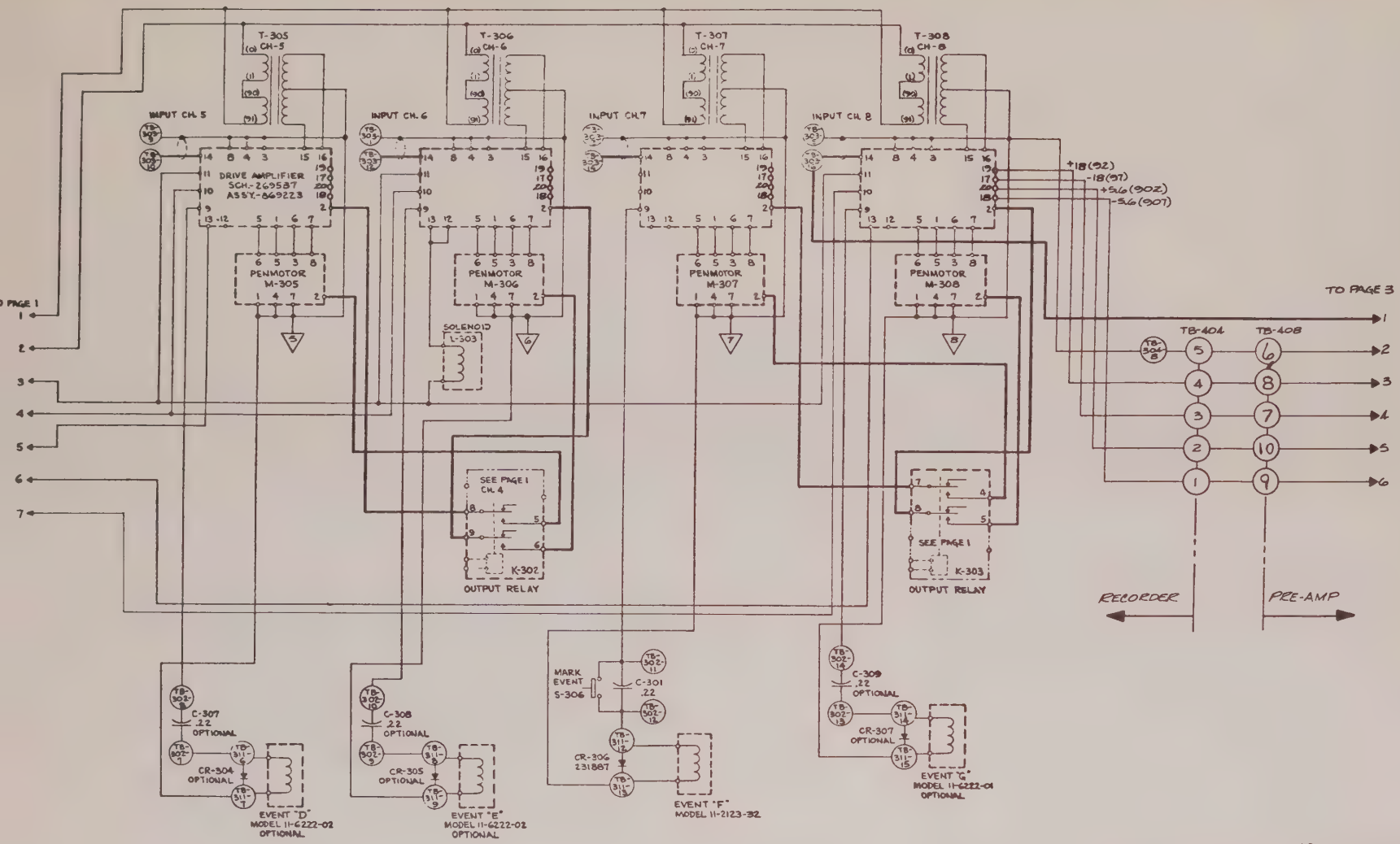
RECORDER, MK 481

BY	DATE	NAME	Gould Inc. Instrument Systems Division
DR. KISNER	8/25/72	SCHEMATIC MODEL NO. 15-6687-01	Cleveland, Ohio 44114 U.S.A.
CH. V.L.	8/29/72		DWG. NO. 282993
APP. P. McCAHAN	8/30/72	CODE IDENT 96795	SIZE CODE G
			PAGE 3 OF 3

282993


REV. B-4
T-301 CH-1
T-302 CH-2
T-303 CH-3
T-304 CH-4
B-301 FAN
DS-301
C-303 1.0
A.C. OUTLET J-301
A.C. LINE P-302
F-302 1.5A S.B.
F-301 5.0A S.B.
S-303
POWER
S-307
INPUT CH. 1
INPUT CH. 2
INPUT CH. 3
INPUT CH. 4
DRIVE AMPLIFIER SCH-269587 ASSY. 869223
TO PREAMP-PAGE 3
PENMOTOR M-301
PENMOTOR M-302
PENMOTOR M-303
PENMOTOR M-304
SOLENOID L-301
SOLENOID L-302
TO PAGE 2
S-309 PAPER INTER-LOCK
S-302
OFF
CHART SPEED MM/SEC.
5
10
25
50
100
200
R-306 1.8K
R-305 1.8K
R-304 1.8K
S-301
+100
R-302 1.8K
S-305
SEE PAGE 2 CH. 7 & 8
SEE PAGE 2 CH. 5 & 6
K-303
K-301
K-302
OUTPUT RELAY
R-303 10
S-308 TIMER SWITCH
C-305 .22 OPTIONAL
CR-301 OPTIONAL
EVENT "A" MODEL 11-6222-02 OPTIONAL
MARK EVENT S-304
C-302 .22
CR-302 231887
EVENT "B" MODEL 11-2123-52
C-306 .22 OPTIONAL
CR-303 OPTIONAL
EVENT "C" MODEL 11-6222-02 OPTIONAL
C-304 5
TRANSMISSION MODEL 12-2137-16
A-302
DRIVE MOTOR B-302
TRANSMISSON & MOTOR ASS'Y. 869882
A-301
TIMER MODEL RA-2101-12 OPTIONAL
RECORDER, MK 481, 230V, 50 Hz
SCHEMATIC
DR. A. ISNER 8/5/72
CH. V. ...
APP. P. McCAHAN 8/11/72
CODE IDENT 96795
SIZE D
CODE
Gould Inc. Instrument Systems Division Cleveland Ohio 44114 U.S.A.
DWG. NO. 283224
PAGE 1 OF 3
283241

REV. B-4

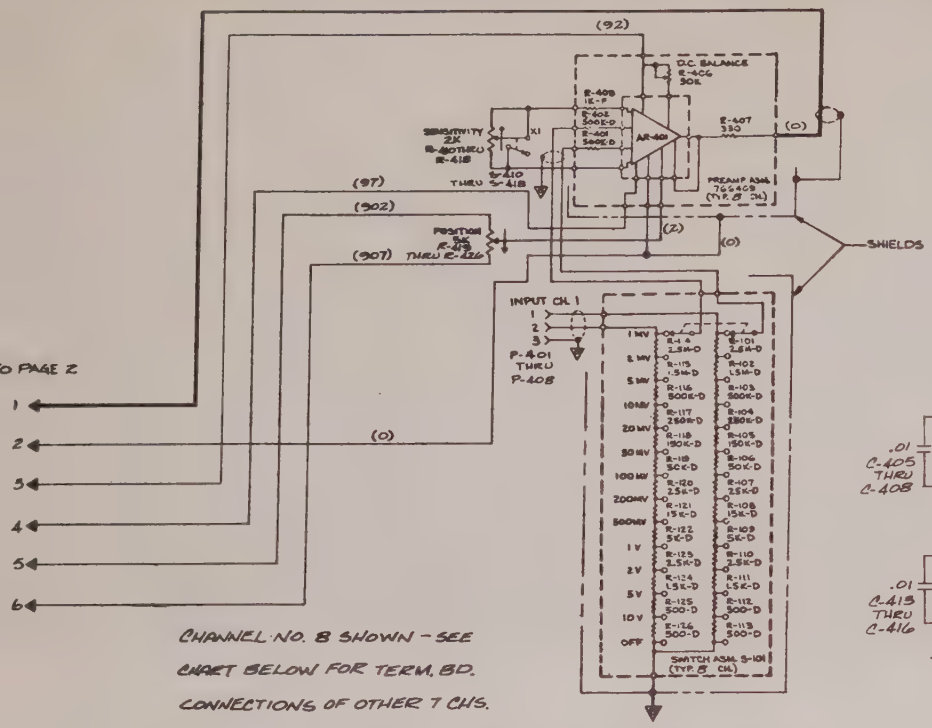


RECORDER, MK 481, 230V, 50Hz

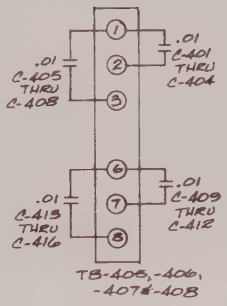
BY	DATE	NAME	
DR. MISNER	4/6/72	SCHEMATIC	
CH.	4/11/72	CODE IDENT	96795
APP. P. McCAHAN	4/11/72	ISSUE CODE	G

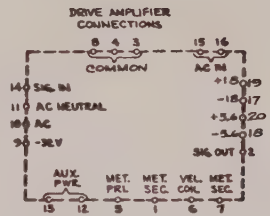
Gould Inc
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.
DWG NO. 283224
PAGE 2 OF 3

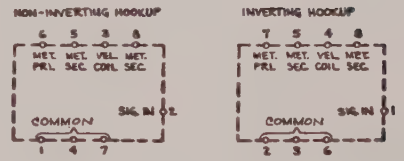
283224



CHANNEL NO. 8 SHOWN - SEE CHART BELOW FOR TERM. BD. CONNECTIONS OF OTHER 7 CHS.







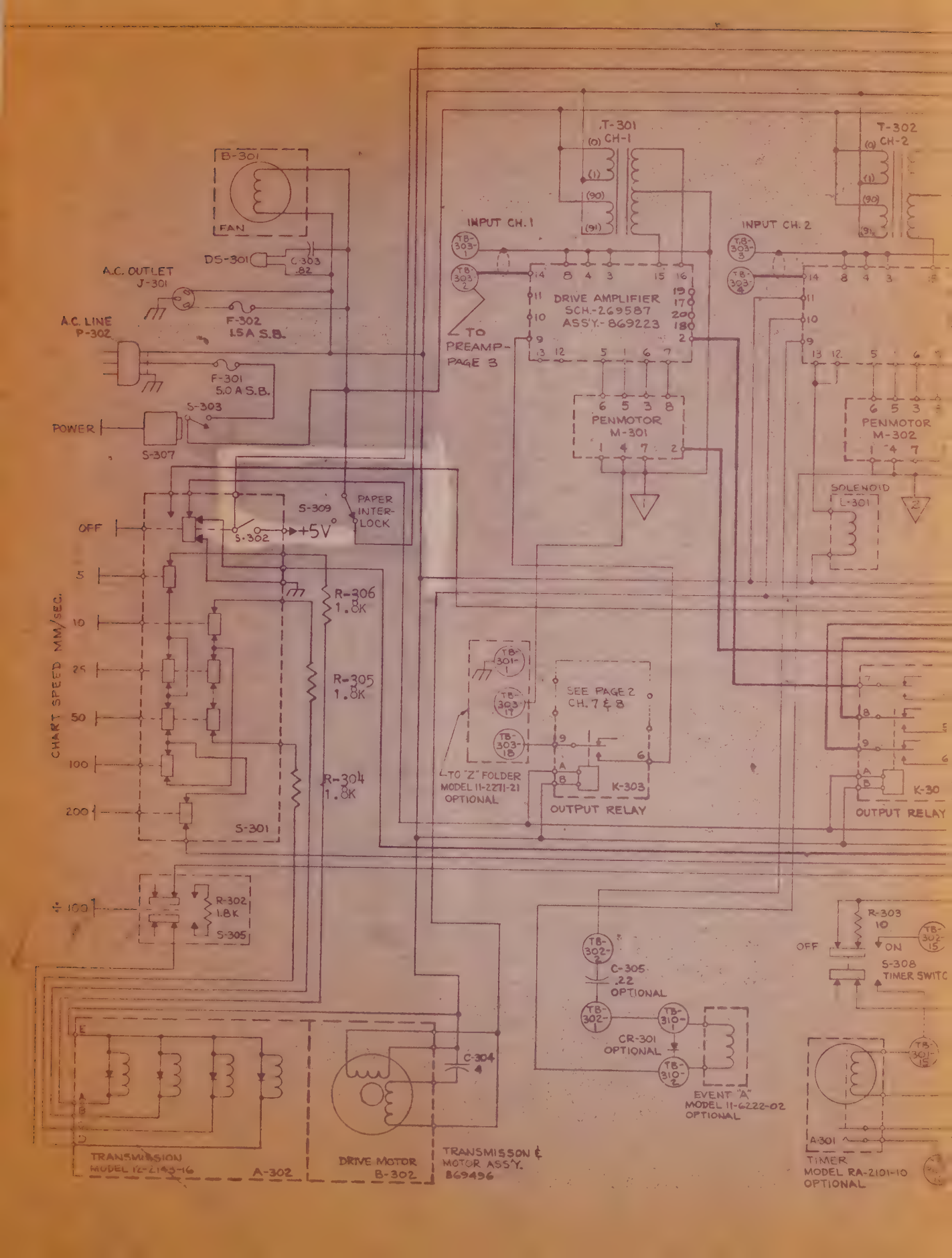
TERM. BD.		304	401	402	403	404	405	406	407	408	303
CONTACT	1	1 0	2 907	4 907	6 907	8 907	1 0	3 0	5 0	7 0	1
	2	2 0	2 902	4 902	6 902	8 902	1 97	3 97	5 97	7 97	1 0
	3	3 0	2 97	4 97	6 97	8 97	1 92	3 92	5 92	7 92	2
	4	4 0	2 92	4 92	6 92	8 92	1 907	3 907	5 907	7 907	2 0
	5	5 0	2 0	4 0	6 0	8 0	1 902	3 902	5 902	7 902	3
	6	6 0	1 907	3 907	5 907	7 907	2 0	4 0	6 0	8 0	3 0
	7	7 0	1 902	3 902	5 902	7 902	2 97	4 97	6 97	8 97	4
	8	8 0	1 97	3 97	5 97	7 97	2 92	4 92	6 92	8 92	4 0
	9		1 92	3 92	5 92	7 92	2 907	4 907	6 907	8 907	5
CONTACT	10		1 0	3 0	5 0	7 0	2 902	4 902	6 902	8 902	5 0

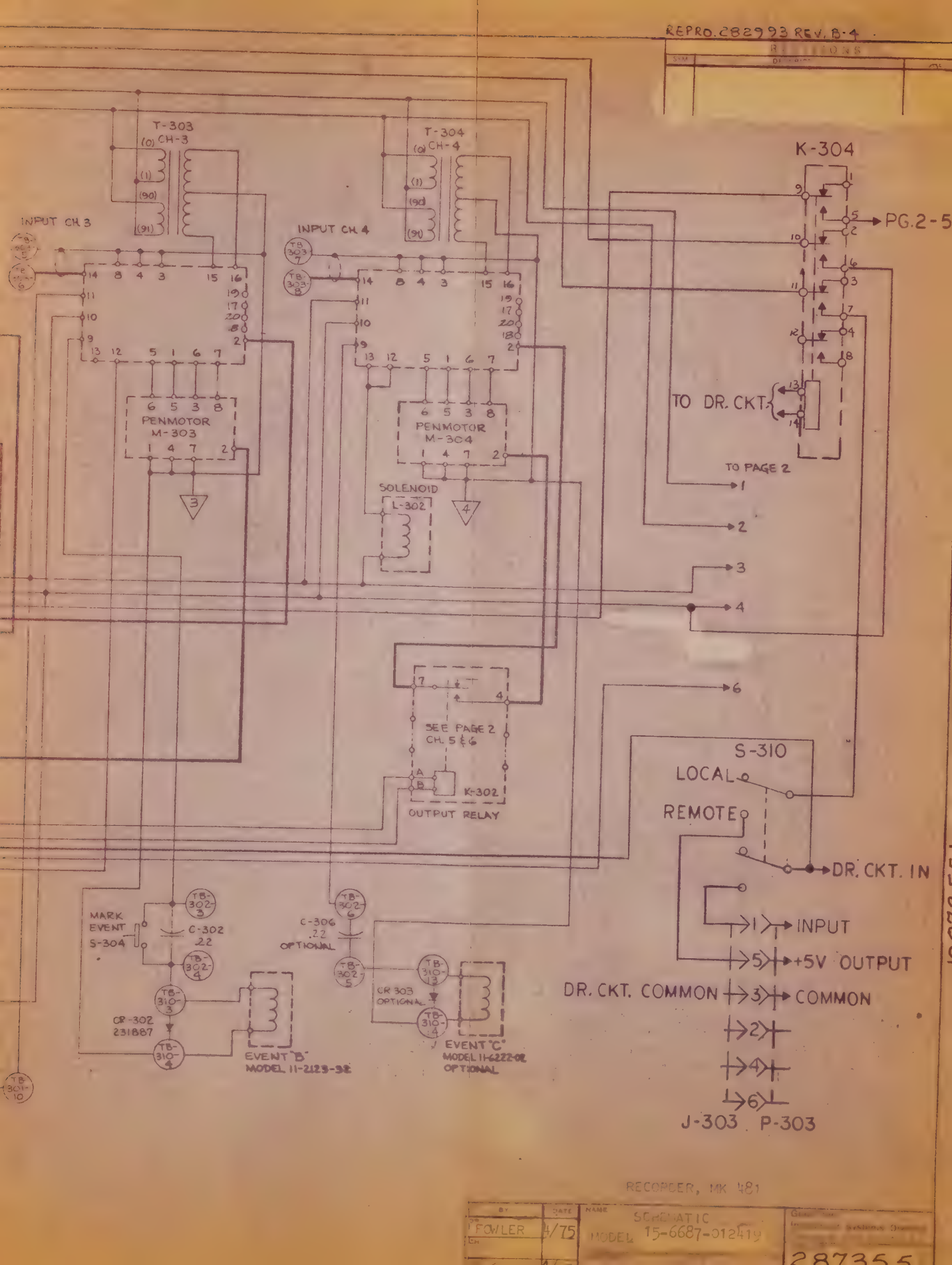
WIRE COLOR
CH. NO.
TYP. 8 CHS.

NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTOR VALUES IN OHMS.
   ALL RESISTORS 5% TOLERANCE.
   ALL CAPACITOR VALUES IN MICROFARADS.
2. HEAVY LINES REPRESENT SIGNAL FLOW.
3. SCHEMATIC ILLUSTRATES NON-INVERTING HOOKUP TO PENMOTOR.
4. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).

RECORDER, MV-8", 230V, 50 Hz

BY	DATE	NAME	SCHEMATIC	Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.
DR. KISNER	9/11/72	MODEL NO. 13-6687-01		
CH. V.L.	9/11/72	CODE IDENT. 96795	SCALE	DWG. 283224
E. McCAHAN	9/11/72			PAGE 3 OF 3

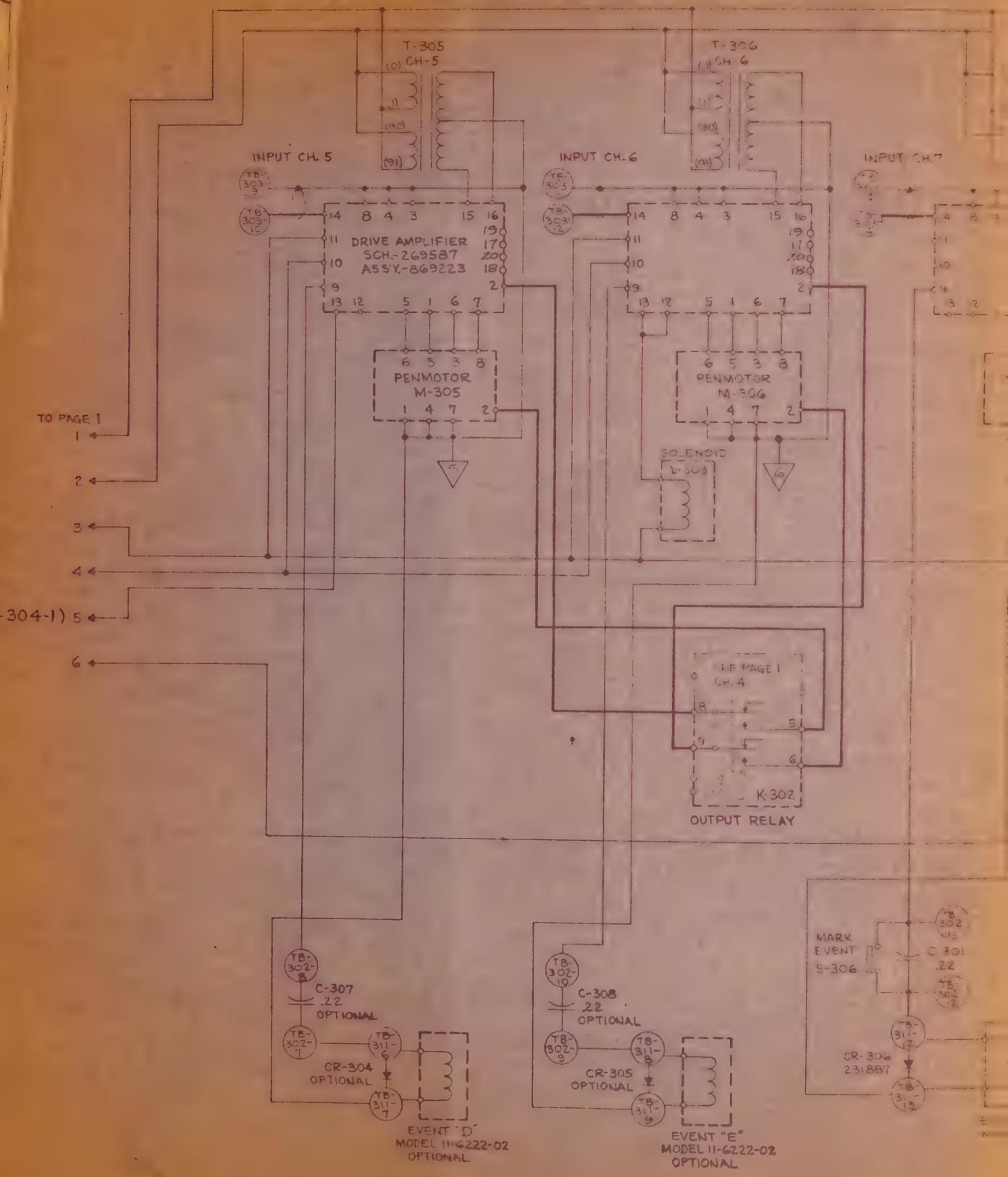

B-301
FAN
DS-301
C-303
.82
A.C. OUTLET
J-301
A.C. LINE
P-302
F-302
1.5A S.B.
F-301
5.0 A S.B.
S-303
POWER
S-307
T-301
(0) CH-1
(1)
(90)
(91)
T-302
(0) CH-2
(1)
(90)
(91)
INPUT CH. 1
INPUT CH. 2
TB-303-1
TB-303-2
TB-303-3
TB-303-4
TO PREAMP-PAGE 3
DRIVE AMPLIFIER
SCH.-269587
ASS'Y.-869223
PENMOTOR
M-301
PENMOTOR
M-302
SOLENOID
L-301
S-309
PAPER INTER-LOCK
OFF
S-302
+5V
5
10
25
50
100
200
CHART SPEED MM/SEC.
R-306
1.8K
R-305
1.8K
R-304
1.8K
S-301
R-302
1.8K
S-305
TB-301-1
TB-303-17
TB-303-18
SEE PAGE 2
CH. 7 & 8
TO "Z" FOLDER
MODEL 11-2271-21
OPTIONAL
K-303
OUTPUT RELAY
K-30
OUTPUT RELAY
R-303
10
OFF
ON
S-308
TIMER SWITC
TB-302-2
C-305
.22
OPTIONAL
TB-302-1
TB-310-1
TB-310-2
CR-301
OPTIONAL
EVENT "A"
MODEL 11-6222-02
OPTIONAL
TB-301-15
A-301
TIMER
MODEL RA-2101-10
OPTIONAL
C-304
TRANSMISSION
MODEL 12-2143-16
A-302
DRIVE MOTOR
B-302
TRANSMISSON &
MOTOR ASS'Y.
869496

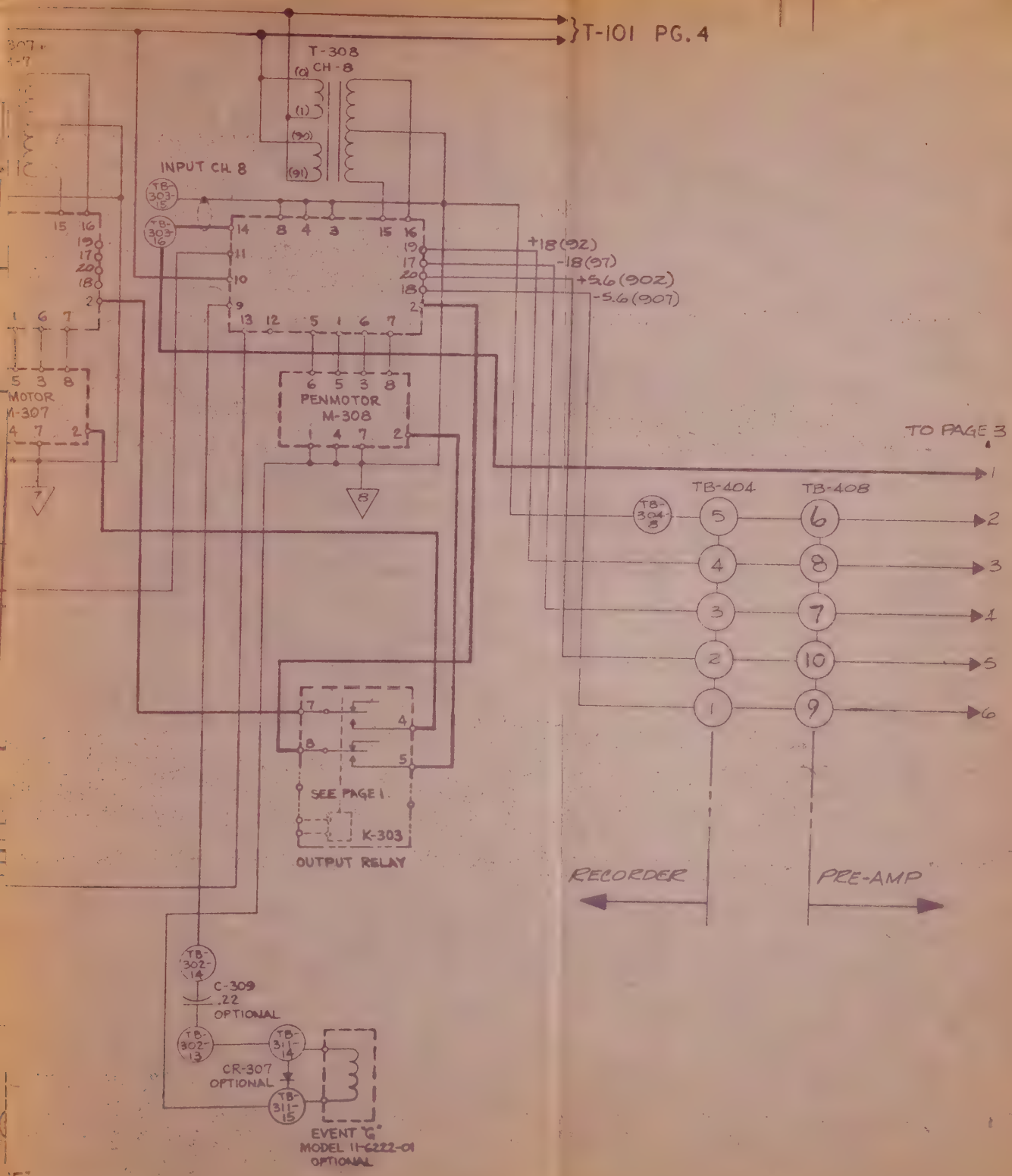


RECORDER, MK 481

BY	DATE	NAME	SCHEMATIC
FOWLER	4/75	MODEL	15-6687-012419

287355

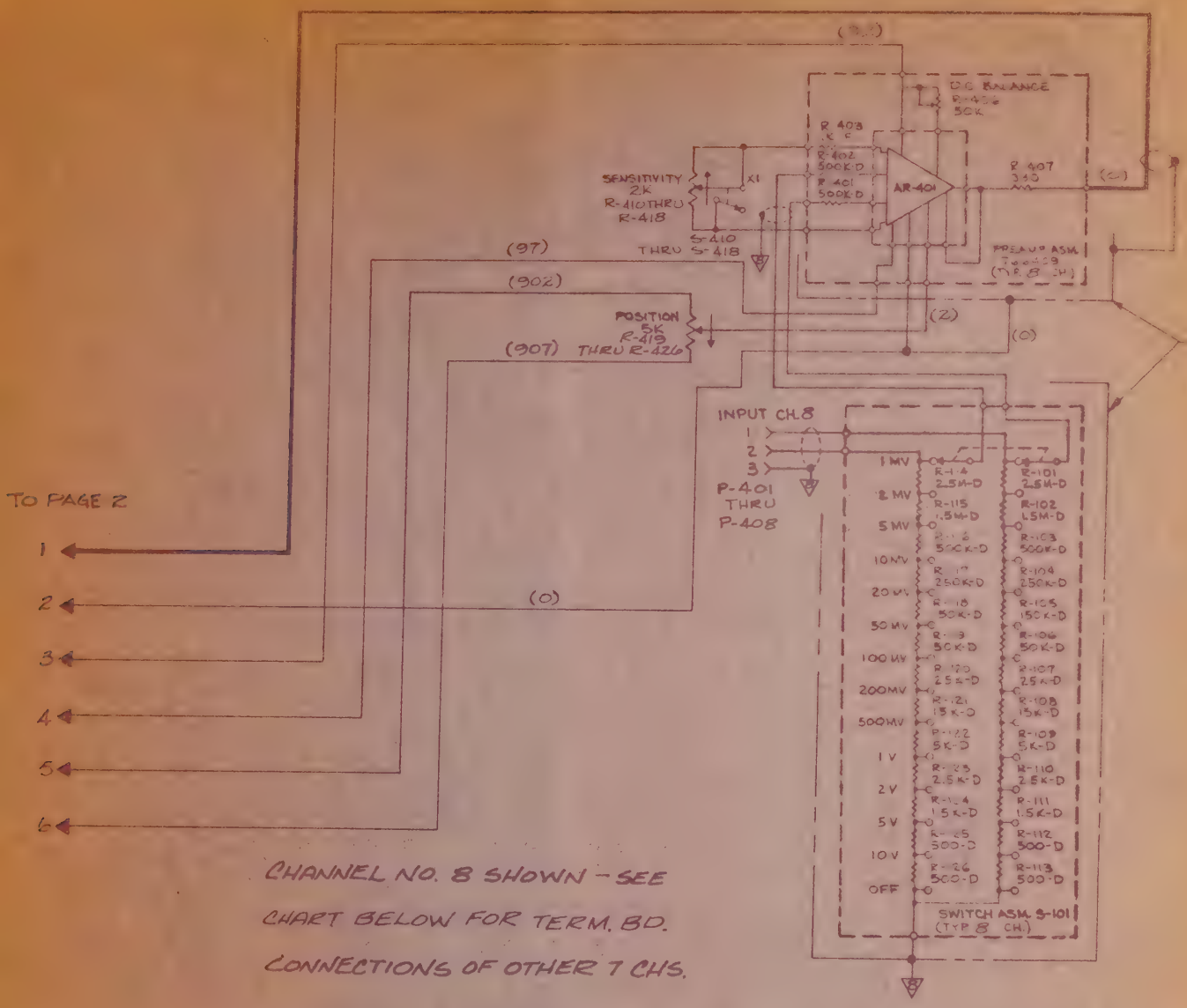

T-305
CH-5
T-306
CH-6
INPUT CH. 5
INPUT CH. 6
INPUT CH. 7
DRIVE AMPLIFIER
SCH.-269587
ASSY.-869223
PENMOTOR
M-305
PENMOTOR
M-306
SOLENOID
L-303
TO PAGE 1
-304-1)
TO PAGE 1
CH. 4
K-302
OUTPUT RELAY
C-307
.22
OPTIONAL
CR-304
OPTIONAL
EVENT "D"
MODEL 11-6222-02
OPTIONAL
C-308
.22
OPTIONAL
CR-305
OPTIONAL
EVENT "E"
MODEL 11-6222-02
OPTIONAL
MARK
EVENT
S-306
C-301
.22
CR-306
231887



"F"
11-2123-32

RECORDER, MK 481

W.E.P.	5/TD	1-303-1111
KLOSS	4/17	287355



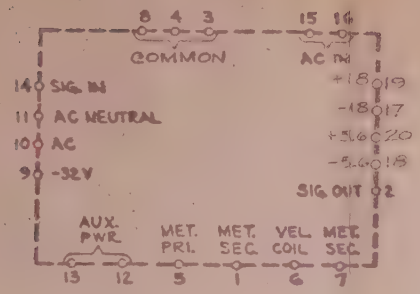
CHANNEL NO. 8 SHOWN - SEE CHART BELOW FOR TERM. BD. CONNECTIONS OF OTHER 7 CHS.

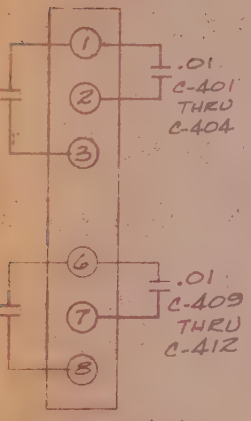
TERM. BD.	304		401		402		403		404		405		406		407		408		303	
CONTACT 1	1	0	2	907	4	907	6	907	8	907	1	0	3	0	5	0	7	0	1	DRAIN
2	2	0	2	902	4	902	6	902	8	902	1	97	3	97	5	97	7	97	1	0
3	3	0	2	97	4	97	6	97	8	97	1	92	3	92	5	92	7	92	2	DRAIN
4	4	0	2	92	4	92	6	92	8	92	1	907	3	907	5	907	7	907	2	0
5	5	0	2	0	4	0	6	0	8	0	1	902	3	902	5	902	7	902	3	DRAIN
6	6	0	1	907	3	907	5	907	7	907	2	0	4	0	6	0	8	0	3	0
7	7	0	1	902	3	902	5	902	7	902	2	97	4	97	6	97	8	97	4	DRAIN
8	8	0	1	97	3	97	5	97	7	97	2	92	4	92	6	92	8	92	4	0
9			1	92	3	92	5	92	7	92	2	907	4	907	6	907	8	907	5	DRAIN
CONTACT 10			1	0	3	0	5	0	7	0	2	902	4	907	6	902	8	902	5	0

WIRE COLOR

AWG NO.

DRIVE AMPLIFIER CONNECTIONS

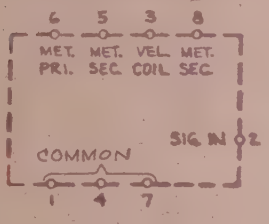




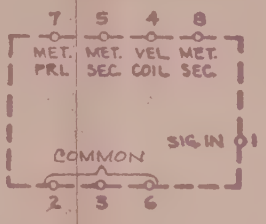
TB-405,-406, -407 & -408

PENMOTOR ASS'Y. NO. 867060

NON-INVERTING HOOKUP



INVERTING HOOKUP



NOTES:
1. UNLESS OTHERWISE INDICATED:
   ALL RESISTOR VALUES IN OHMS.
   ALL RESISTORS 5% TOLERANCE.
   ALL CAPACITOR VALUES IN MICROFARADS.
2. HEAVY LINES REPRESENT SIGNAL FLOW.
3. SCHEMATIC ILLUSTRATES NON-INVERTING HOOKUP TO PENMOTOR.
4. WIRE COLORS IN EIA COLOR CODE SHOWN IN PARENTHESIS ( ).

RECORDER, MK 481

SCHEMATIC
SIZE 15-6687-012419
287355
96795
KLOSS 4/17

287355

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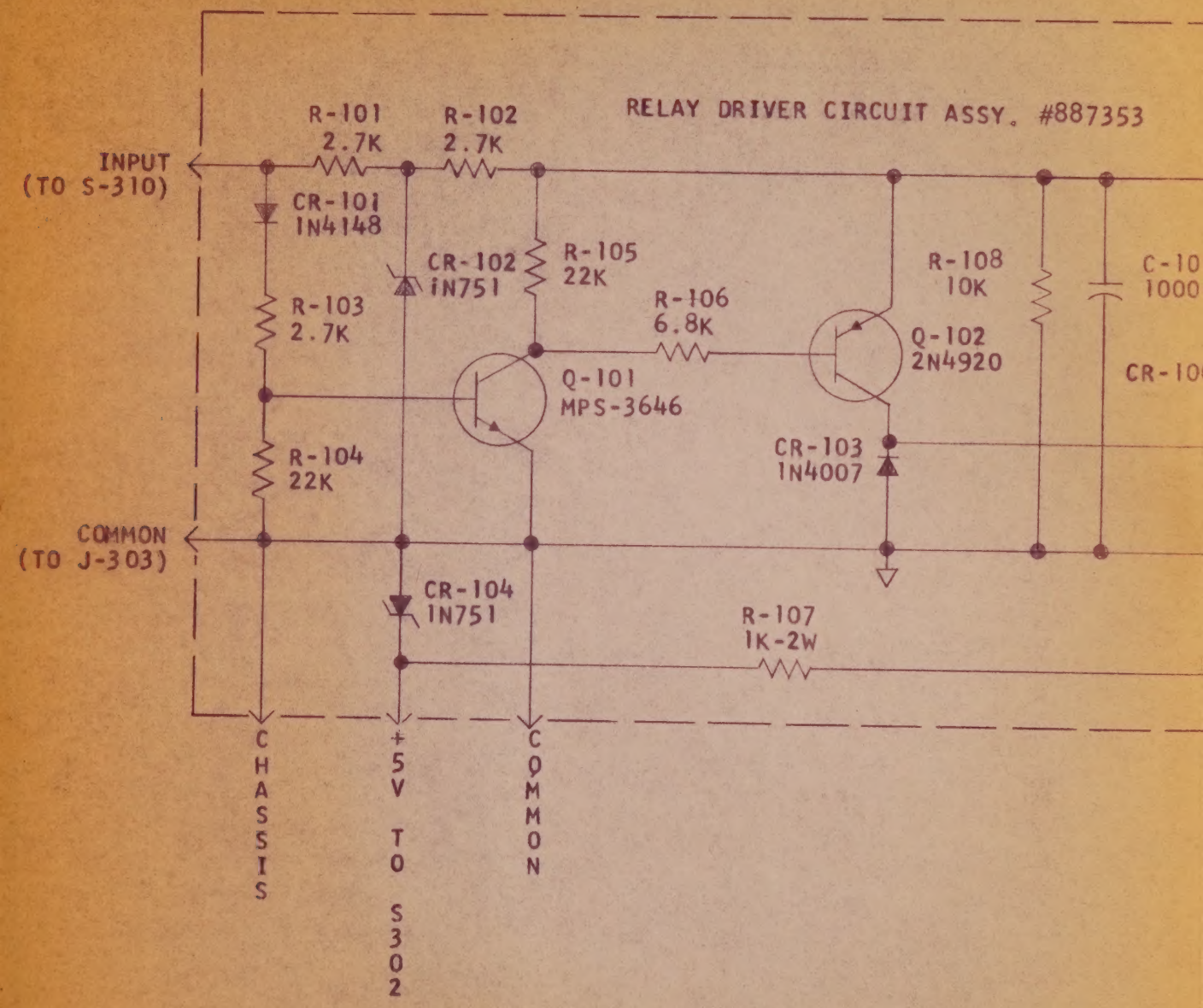


REQD	ITEM	PART NUMBER

15-6687-01 2419

UNLESS OTHERWISE SPECIFIED

DIMENSIONS ARE IN INCHES AND INCLUDE PLATING

.XXX = ± .005 SURFACE FINISH

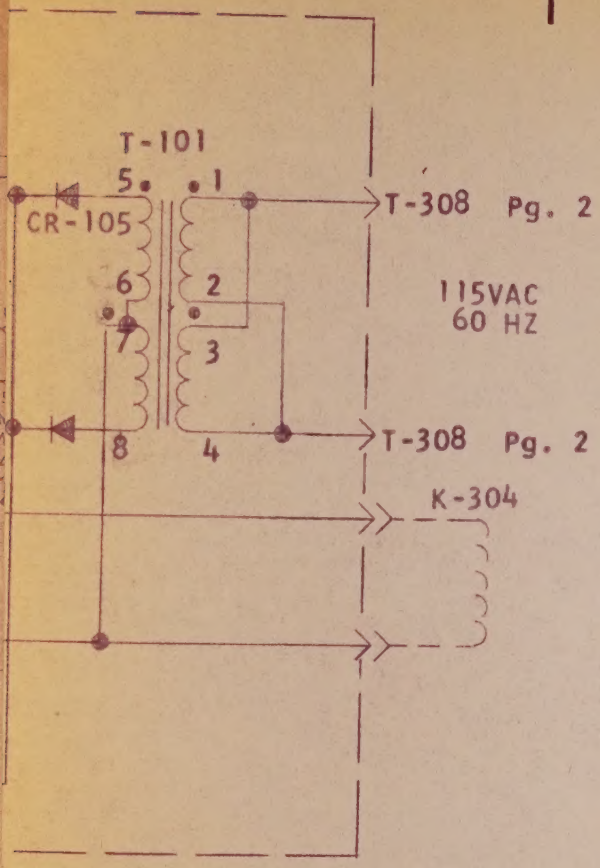
.XX = ± .015

.X = ± .06 ANGLES = ± 0° 30′

MATL.

FIRST USE

REVISIONS		
SYM.	DESCRIPTION	DATE



DESCRIPTION	REMARKS	CML

LIST OF MATERIAL

BY	DATE
R. FOWLER	4/16/75
PP. KLOSS	4/17/75

DD. FIN. _____

NAME: SCHEMATIC
MODEL #15-6687-012419

Gould Inc.
Instrument Systems Division
Cleveland, Ohio 44114 U.S.A.

FED. CODE NO.	ISSUE CODE	DWG. NO.
96795	G	287355
SCALE _____		PAGE 4 of 4 PAGES

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1026390

Gould Inc., Instrument Systems Division
3631 Perkins Avenue, Cleveland, Ohio 44114
Telephone (216) 361-3315

GOULD